SILICON CHIP

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March 2012

5.8GHZ AV SENDER EXPERIMENTERS KIT WITH IR RECEIVERS

All AV sender transmitters are limited to strict controls and output power. This unit is for qualified and licensed amateur radio experimenters only as it has ten times the output power of standard units (100mW). In keeping with the experimental nature of the unit, it is not ready to plug in. Several parts such as the supplied RCA sockets need to be soldered in. It also doesn't come with a set of cases. It uses a standard 9V adaptor that comes with the unit. The extra power works well with experiments in, say concrete buildings with lots of reinforcing steel. In all respects except output power, it's identical to AR-1840 AV sender.

- Video input: NTSC or PAL
- IR frequency: 433.92MHz
- IR modulation: ASK
- IR carrier: 30 - 60kHz
- Range: Up to 300m (line of sight)
- Operating frequency: 5.76 - 5.86GHz (6 channels)
- Transmission power: 20 dBm (100mW)
- Receiver sensitivity: -85dBm
- Operating voltage: 9VDC
- Power consumption: TX: max. 500mA @9V RX: max. 400mA @9V
- Dimensions: TX/RX PCB: 111(L) x 62(W)mm

AR-1849 WAS $249.00

$149.00 SAVE $100

GAS SENSORS

General air contaminants including: n-Hexane, Benzene, NH³ (Ammonia), Alcohol, smoke, CO (Carbon Monoxide. Sensitivity to individual gases varies). Application includes automotive, mining, industrial etc. See website for comprehensive data.

CARBON DIOXIDE (350 - 10,000PPM)

- Good CO_2 sensitivity
- Operates over wider temp/humidity range
- Long term stability and reproducibility
- Element behind stainless steel mesh

RS-5600 WAS $59.95

$39.95 SAVE $20.00

CARBON MONOXIDE (20 – 2,000PPM)

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- Very stable, long life
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- Carbon monoxide + combustible gas

RS-5615 WAS $29.95

$19.95 SAVE $10.00

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Panel Mount 10Pk	**HP-1306**	$6.95
Removeable 2Pk	**HP-1308**	$3.95
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From **$1.95**

HP-1300 HP-1304 HP-1308

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Featuring a patented Nanoflux bearing that incorporates magnetic levitation technology, these premium quality fans ensure an extremely long operational life, extremely low noise levels compared to traditional ball bearings, and also offers the ability for the fan impeller to be removed for cleaning. Dust and waterproof to IP54, line up these fans are sure to last even in harsh conditions. See our website for full specifications.

- 12VDC
- Flylead with 3 pin molex connector
- Polycarbonate housing
- UV reactive polycarbonate impellers

12VDC 80mm	**YX-2580**	$24.95	From
12VDC 90mm	**YX-2582**	$29.95	**$24.95**
12VDC 120mm	**YX-2584**	$34.95	

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These tiny LED drivers are designed to run modern high power LEDs and are perfect for our Cree® and Edixeon range. They come fully encapsulated for improved environmental protection and have just four wires to connect the LEDs and power source.

From **$9.95** SAVE $6.00

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WAS $15.95 NOW $9.95 SAVE $6.00
1W 9-30VDC 1-6 LEDs AA-0592
WAS $19.95 NOW $9.95 SAVE $10.00
3W 9-30VDC 1-6 LEDs AA-0594
WAS $24.95 NOW $19.95 SAVE $5.00
12-30VDC 1-3 LEDs Dimmable AA-0596
WAS $24.95 NOW $19.95 SAVE $5.00

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Specially designed for connecting electronic circuits to telephone lines. High dielectric insulation, PCB mounting, will handle quite substantial signals without saturation.

- ACMA approved
- Dimensions: 40(W) x 32(H) x 33(D)mm

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$12.95 SAVE $5.00

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WAS $49.95 NOW $34.95 SAVE $15.00

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Cree® XR LEDs offer market-leading lumen output and efficiency combined with excellent lumen maintenance. They deliver over 100 lumens at 350mA, and 250 lumens at 1000mA for cool white and are suitable for practically any low voltage lighting application.

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Warm White	**ZD-0444**	$12.95

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15˚	**HP-1292**	$2.95
25˚	**HP-1294**	$2.95

$2.95 ea

Collimator Lenses for CREE® LEDs

Collimator lenses are designed to increase LED efficiency by reducing light loss caused by 'beam spreading' and provide a brighter more focused beam. They are suitable for our Cree® Star LEDs and available in three dispersion angles.

10˚	**HP-1296**	$7.95
25˚	**HP-1297**	$7.95
45˚	**HP-1298**	$7.95

$7.95 ea

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3 DAY SALE

THURSDAY 22nd - SATURDAY 24th MARCH 2012

BENCH GRINDERS
- 240V motor
- Fitted with eye shields & tool rests
- Ø150mm (G150)
- Ø200mm (G199)

$99 (G150) SAVE $11

$109 (G158) SAVE $28.50

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- Vector smoke outdoor use (W106)
- U.V. protection
- Hard-coat anti-scratch lens

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$9.90 (W106) OUTDOOR USE

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$22 (W102) SAVE $5.50

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- Tyre inflator with gauge
- Dusting gun with self coil hose

$33 (B440) SAVE $6.60

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- 2.75hp motor
- 205L/min free air delivery
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HOT PRICE

$308 (C325) SAVE $55

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SAVE 20%

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SAVE 15%

$45 (T012) ALLOY STEEL

$99 (T013) HSS

EDBD-13 DRILL SHARPENER
- Economy drill bit sharpener with split point feature
- 80W 4200rpm 240V DC motor

SAVE 15%

$107 (D070) 3-13mm RANGE

JOBBER DRILL SET
- 170 Piece 1-10mm • HSS

$149 (C126) SAVE $36.90

DRILLING MACHINES
- 20mm drill capacity
- 1hp 240V motor
- Micro switch on belt cover
- 16 spindle speeds
- 2MT

HOT PRICE

BENCH $309 (D144) SAVE $43

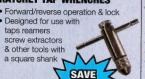
1/PEDESTAL $349 (D147) SAVE $47

SOLID CARBIDE BURR SET
- Double cut industrial quality
- 3/8" x 1/2" sizes
- 1/4" shank

SAVE 20%

$66 (B900) CARBIDE

RATCHET TAP WRENCHES
- Forward/reverse operation & lock
- Designed for use with taps reamers screw extractors & other tools with a square shank



SAVE 15%

$13 (T800) NO.1 M3-M10

$16 (T661) NO.2 M5-M12

INDUSTRIAL WET & DRY VACUUM COLLEAN
INCLUDES:
- 1 brush
- 1 dry floor nozzle
- 1 crevice tool
- 1 wet floor nozzle

30L 1000W 240V

$165 (V503) SAVE $33

SCREW PITCH THREAD GAUGE
- 28 Imperial (4-62TPI)
- 23 Metric (0.4-7mm pitch)

$13 (G610) 55 & 60°

FEELER GAUGE

$14 (G616) 0.03 - 1.0mm

SPRING DIVIDER/CALIPERS
- Polished finish

SAVE 15%

Divider $8 (G634)

Inside $8 (G635)

Outside $8 (G636)

PUNCH SETS

SAVE 15%

3/16" Letter $35 (P350)

3/16" Number $16.50 (P351)

5/16" Letter $45 (P354)

5/16" Number $19 (P355)

EXTRA LONG BALL END HEX KEY SET
- Metric 1.5-10mm
- Flip open design
- Ball head design allows turning of hard to reach fasteners
- 9 piece

SAVE 40%

$9.90 (H801) METRIC

SECOND CUT FILE SET-200mm
- Cushion grip handles
- Flat, round, 1/2 round, square & triangular

$22 (F100) 5 PIECE SET

SAVE 30%

BENCH VICES - Cast Steel
- Fitted with replaceable nut
- Acme screw thread

SAVE 20%

100mm / 4" $49 (V089)

125mm / 5" $79 (V089)

150mm / 6" $109 (V090)

BENCH VICES
- Offset fabricated - 152mm jaw width
- Multi purpose - 125mm jaw width

OFFSET $99 (V067) SAVE $33

MULTI PURPOSE $139 (V074) SAVE $26

FLEXI-RACK WOOD SHELVING
- 455kgs shelf load capacity
- Multiple configurations
- Can be configured as a work bench
- Industrial grade steel
- Adjustable shelves
- 4 shelves made from 16mm thick particle board
- 1040 x 430 x 1830mm (L x W x H)

$154 (B013) SAVE $22

HOT PRICE

RSS-4S INDUSTRIAL STEEL SHELVING
- Industrial 4 Shelf rack with strong wire mesh
- 364kg capacity per shelf
- 1955 x 610 x 1830mm (L x W x H)
- Silver corrosive resistant powder coated finish
- Adjustable grid pattern wire shelving
- Vertical posts have double sided punched holes allowing to link units together

$275 (S010) SAVE $44

TOOLING CABINET WORKSTATION
- Drawer capacity 100kg each
- 110 x 580 x 940mm (W x D x H)
- Portable on caster wheels
- Key lockable drawers & cupboard
- 950mm work bench height
- 9 drawers

HOT PRICE

$799 (T7701) SAVE $191

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DIGITAL ANGLE RULES

- Absolute & incremental
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- 360° Range

SAVE 15%

180mm / 7"	$27.50	(M970)
280mm / 11"	$33	(M972)
480mm / 18"	$39.60	(M974)

DIGITAL CALIPERS IP-54 SPLASH PROOF

- Auto on & memory hold, accuracy DIN862
- Large LCD on/off, metric/imperial
- 0.01mm / 0.0005" resolution

SAVE 15%

$82.50 (Q1751)	$104.50 (Q1761)	$165 (Q1771)
150mm / 6"	200mm / 8"	300mm / 12"

DIGITAL BEVEL BOX

- Digital readout display
- 3 embedded disc magnets on base
- 0.1 degree resolution

SAVE 25%

$49.50 (M977)
RANGE 180°

FLUORESCENT WORK LIGHTS

- Designed with magnifier lens (L282)
- Double lamp tubes (L2825)
- Long arm
- 240V

22 WATTS	36 WATTS
$132 (L282)	$148.50 (L2825)
SAVE $27.50	SAVE $27.50

DIGITAL SCALE WITH DISPLAY UNIT

- On/off in any position
- Remembers the last setting
- Metric or imperial digits
- Mini USB connection to the display unit

150mm	300 mm
$66 (D665)	$88 (D667)
SAVE $20.90	SAVE $20.90

NIC PORTABLE VIDEO SCOPE

- 1 metre flexible cable with camera & LED lighting
- Includes: 2 metre extension cable, pick up hook, magnetic pick up tool ,mirror tool & carry case

$159.50 (M697)
SAVE $33

OUTSIDE MICROMETER 4 PIECE SET

- Easy adjustment for recalibrating
- Carbide tipped anvils, flatness 0.0008mm
- Micro-fine clear graduations on satin chrome finish
- Painted cast frame
- Resolution 0.01mm
- 0-100mm range

$132 (Q114)
SAVE $28.60

RUBBER MATS

- 1505 x 905mm (8mm thick)
- Ideal for the workshop or ute
- Tapered edge
- 910 x 910mm (10mm thick)
- Clips together

$39 (M800)	$29 (M805)
ANTI FATIGUE	910 x 910mm

6 PIECE PIN PUNCH SET

- 6pc pin punches (tip diameter x shaft hex x length)
- Ø3 x 10 x 150mm
- Ø4 x 10 x 150mm
- Ø5 x 10 x 150mm
- Ø6 x 10 x 150mm
- Ø7 x 12 x 150mm
- Ø8 x 12 x 150mm

SAVE 15%

$16.50 (P365)

14 PIECE PUNCH & CHISEL SET

- 5 x flat cold chisels
- 4 x tapered punches
- 4 x pin punches
- 1 x center punch

SAVE 20%

$38.50 (P354)

PIPE BENDERS 1/2-2"

- Includes 6 pipe formers to suit: 1/2", 3/4", 1", 1-1/4", 1-1/2", 2"

$165 (P068)
SAVE $33

$229 (P068)
SAVE $46

UB-100 BAR BENDER

COLD BENDING

- Flat: 100 x 5mm - Square: 16 x 16mm
- Round: Ø18mm diameter

HOT PRICE

$198 (B043)
SAVE $22

ENGINE TEAR DOWN TABLE

- 1220 x 710mm table top
- Key lockable drawer
- Storage tray

HOT PRICE

$242 (A385)
SAVE $55

TOOL CHEST & ROLLER CABINET

6 Drawer Tool Chest $77 (T690)

- Lockable by key
- Ball bearing slides

5 Drawer Roller Cabinet $176 (T695)

- Lockable by key
- Ball bearing slides

PACKAGE PRICE ONLY $239
(K804)

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- Ø127mm Rubber Wheels (T670)
- Ø203mm Pneumatic Wheels (T672)
- 300kg capacity
- 907 x 609mm platform
- Handles fold flat
- 2 fixed & 2 swivel wheels

HOT PRICE

$77 (T670)
SAVE $11

$99 (T672)
SAVE $33

APW-14 AUTO PARTS WASHER

- Wall or bench mount type
- 240V input
- Includes: internal light & cleaning brush with gun
- 14 litre tank capacity
- Tank size (L x W x D) 520 x 540 x 39mm

HOT PRICE

$154 (A369)
SAVE $22

AL-250G BENCH LATHE

- 0.75kW / 1hp, 240V motor
- 250 x 500mm
- 12 spindle speeds (80-1600rpm)
- Metric thread cutting
- Thread chasing dial
- Quick action tailstock locking lever
- Forward/reverse spindle switch

HOT PRICE

$1,495 (L149)
SAVE $144

OPTIONAL STAND
$250 (L150)
SAVE $25

HM-36 MILL DRILL

- 1.1kW / 1.5hp 240V motor
- 3MT spindle, 6 speeds (95-1600rpm)
- Gear driven head
- Tilting head to ±90° from vertical
- 730 x 210mm ground work table with T-slots
- Inludes: Drill chuck, 3MT arbor, 3MT-2MT drill sleeve, multi-point facing cutter & safety cutter guard

HOT PRICE

$1,529 (M122)
SAVE $220

OPTIONAL STAND
$220 (M136A)
SAVE $77

PROCRAFT 240 MIG WELDER

- 30-240 Amps, 240V
- DC MMA
- Gas / gasless MIG
- Spool size 5 & 15kg
- Includes: gas hose, argong regulator, 3 metre earth lead & MIG torch

$880 (W185)
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Publisher's Letter

Innovation is the key to success

In this month's issue, we have two interesting articles on manufacturing but the stories are far apart chronologically. The older one is the story on the manufacture of Atwater Kent radios, a now legendary brand of vintage radio. The story is illustrated by some wonderful photos processed and enhanced by Kevin Poulter from scans of 4 x 5-inch glass negatives held in the US Library of Congress. The Atwater Kent factory was a huge facility employing 12,000 people at its peak and it grew to that size in only a few years.

Arthur Atwater Kent was clearly a great entrepreneur who drove the whole process, over 80 years ago. Innovation was the key to success. This applied not only to the manufacture of the goods but also to the aggressive marketing of the radios. Atwater Kent had a huge advertising budget. There is a very close parallel today to another American company which is renowned for innovation in its products, rapid growth and very successful marketing: Apple.

The other story is on an Australian development, Vertical Farms, which we think could be the basis of a great deal of factory farming in the future. This combines artificial lighting provided by high intensity red and blue LEDs, with bioponics (not quite the same as hydroponics), to enable intense horticulture in large multi-level modules, all under computer control. This technology has been developed in Australia and is already attracting considerable interest both here and overseas, particularly for the production of fresh vegetable in remote desert areas.

Are similar processes being developed overseas? Quite possibly. But if Australian manufacturing is to have any real chance of competing on the world market, it can only be done with innovative products and processes because we are otherwise at a severe disadvantage with our relatively high labour costs and very strong currency. We wish Vertical Farms every success in their venture.

Cinemas and theatres are excessively loud

As I write this editorial I am a bit bleary-eyed, having last night seen Andrew Lloyd Webber's latest live musical show, "Love Never Dies", at Sydney's rococo Capitol Theatre. This is the sequel to "The Phantom of the Opera". I have to say that I thoroughly enjoyed it: the music, the singing, the orchestra, dancing, choreography, the elaborate set, costumes, lighting and so on. The elaborate set was remarkable for its complexity and the way in which it was used to frame so many different scenes.

In fact, it has to be said that each new live musical show these days seems to strive to be yet another tour de force, with elaborate sets, big casts and orchestras and so on. You can point to any number of recent instances, such as the musical "Wicked", several recent opera and ballet productions or tours by big bands, Andrew Rieu, and so on. They are very expensive to produce and generally very successful in creating a great spectacle.

So why do they persist in making them too loud? I know that they are trying to create drama. I know they need crescendos. But it is difficult to create crescendos if the sound levels are already loud.

Sound engineers should realise that loud music does not equate to excellence; drama should not equal bedlam. I know that half the population is probably half deaf or too stupid to know that loud music is exactly the same as loud noise when it comes to damaging your hearing. But the other half of the population is not deaf; why do they put up with it? They complain about it among themselves. Why don't they complain to the management of the venue?

The really silly aspect of this is that if people were subjected to the same level of noise in their workplace they would expect to be issued with ear plugs or else there would be danger of prosecution by Workcover.

I routinely take earplugs or cotton wool to protect my ears. What do you do – just sit there and endure it? Nothing will change at these venues until people complain. Loudly.

Leo Simpson

Introducing Microchip's New 16-bit dsPIC33E Digital Signal Controllers and PIC24E Microcontrollers

Easy migration to 60 MIPS performance with Enhanced Core 16-bit DSCs and MCUs

Migrating to 60 MIPS performance is easy as our next generation dsPIC33E DSCs and PIC24E MCUs are fully upwards compatible from our large families of 2nd generation dsPIC33F and PIC24H devices.

Based on the next generation dsPIC® DSC/PIC24 MCU core, the nine new devices pack 536 KB of Flash memory and 52 KB of RAM, with expanded peripheral and I/O capabilities, into packages ranging from 64 to 144 pins. The dsPIC33E and PIC24E controllers give you a USB 2.0 OTG interface, and expanded motor-control, graphics, audio and real-time embedded control capabilities compared to devices based on the previous core.

A new auxiliary Flash module lets you programme on-the-fly and erase Flash data without slowing down your normal CPU operation. Use the new USB 2.0 On-The-Go (OTG) peripheral, four SPI, four UART and two I²C™ interfaces for easy connectivity, and the three on-chip analogue comparators to reduce system cost and the number of external components. Peripheral Pin Select (PPS) allows most digital peripherals to be remapped to any I/O pin promoting customisation and easing board layout.

Your linked DMA operations will be started automatically by the enhanced, fully independent 15-channel DMA controller and an improved debugger gives you complex breakpoints for faster debugging. With new timer capabilities, the dsPIC33E DSCs and PIC24E MCUs also give you more flexible and powerful input-capture and output-compare capabilities.

Microchip Technology Australia
Tel: (02) 9868 6733 E-mail: aust_nz.inquiry@microchip.com

GET STARTED IN 3 EASY STEPS

1. Choose a low-cost dsPIC33E or PIC24E USB Starter Kit
2. Download a free evaluation version of our MPLAB® C Compiler
3. Use one of our many code examples or software libraries to solve your application task

dsPIC33E USB Starter Kit (Part # DM330012)
PIC24E USB Starter Kit (Part # DM240012)

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Banning electric hot-water systems is silly

In regards to Publisher's letter in the January 2012 edition, a further example of the energy needs being in the hands of clowns would be the new restrictions on the use of electric hot-water heaters. Apparently you are no longer allowed to install standard electric hot water heaters in new houses, town houses etc and soon existing installations will not be able to be replaced with a similar system.

Replacement systems have to be solar, gas or heat pump. The logic is that the standard type of heaters produce a large amount of greenhouse emissions. However, as far as I can see, most of these heaters are on "off peak" and are therefore using electricity that has to be generated anyway.

The stupid part is that, assuming you do not have gas and live in a unit or townhouse where the heater is situated internally and therefore cannot fit solar, to replace it with a heat pump type means that you end up with a unit whirring away in your laundry 24 hours a day at normal power rates, putting further loads on the system at peak times. Then there is the purchase cost and reliability issues of the heat pump systems. How is this reducing power demands, saving the environment and lowering power costs?

Rob Leplaw,
Oatley, NSW.

Comment: virtually all small hot-water systems in home units and industrial premises are electric but not off-peak. In most of those situations, gas is not available and since they are small units, heat pumps would be over-kill. Unless these systems can be exempted from the ban, they will be in limbo.

Solar tracker needs better limit switches

The Solar tracker featured in the Circuit Notebook pages of the January 2012 issue looks interesting and will go into my "ideas" folder but I have a couple of comments regarding the so-called "limit" switches.

The switches S1 and S2 described as "limit" switches appear to be there for the sole purpose of signalling IC1 when travel extremities have been reached. I assume this is so IC1 can drive the unit back to the starting position ready for next day operation. This is OK for this application.

The text then states that in the event of a fault they will prevent the motor over running and causing damage. In this case this is not the way to go about "limiting" travel.

Faults of this nature usually are Mosfets turned on permanently by some means or shorted and there is nothing IC1 is going to do about this. Limit switches used to prevent such situations must remove power to the motor.

In fact, manufacturers of commercial devices such as PLCs etc emphasise the fact that safety interlocks and limit switches must not be dependent on said controller's correct operation and should be hard-wired.

Bob Rayner,
Willow Vale, NSW.

Comment: limit switches for the motor

Original Maximite is the best

I have been following the progress of the hugely successful Maximite project in SILICON CHIP with a great deal of interest. Like many of the over 40s, I grew up on Microbees, Sorcerers, CP/M and other weird and wonderful old hardware. The Maximite has reignited an interest in writing code just for the heck of it, not because I want to spend two weeks wading through GUI programming or style guides to create a hello world application without a wizard!

Unfortunately, recent events in both the Maximite and Duinomite camps have left me very disillusioned. The current online "war" between these similar but not "the same" systems can only be likened a group of badly-behaved school boys having a urinating competition.

To me, it appears Geoff has been overwhelmed by the popularity of the project and the huge amount of unpaid work being demanded by genuine Maximite followers who are keen to see the product improve. Likewise, he has seen people commercialising his "baby" and then asking that they also receive the fruits of his free labour so that their products can prosper; probably a very frustrating situation to be in!

The other camp are now crying foul because they, with Geoff's recent decision to, rightly or wrongly, move down a closed source path, will be cut off from the 100% BASIC compatibility claim they cling to to ensure their return on investment. As a result both sides are busy chest-beating, posting derogatory comments about each other and generally dragging what was a brilliant concept through the mud.

I'm hoping that you may be able to use your influence to drag these brats back to the table for a chat on good manners because as it is the end users and your subscribers who are losing out.

Cheers and great work on turning Geoff's original idea into such a huge, albeit controversial, success.

I also need to declare that as it was a Christmas gift from my son I started out in the Duinomite camp but as a result of recent events will be buying a real Maximite.

Ingmar Meins,
Canberra, ACT.

itself (ie, instead of being monitored via the PIC) will solve the problem should the Mosfets fail. But the limit switches will then have to carry the full motor current including starting current. These too can fail by welding shut if they are not sufficiently rated.

In any event, they should be placed to operate only when the panel moves past the original S1/S2 limit switches monitored by the PIC.

Swimming pool sanitisers can be helpful

I refer to your response to B.C.'s letter published on page 100 of your January 2012 edition concerning copper/silver (Cu/Ag) swimming pool sanitisers. You have published several analyses of products whose promoters make false or misleading claims; such analyses help readers such as me to understand and add to the list of good reasons for buying SILICON CHIP.

I consider that, despite its length, your response to B.C. oversimplifies the information presented in the APVMA reference. Nevertheless, thank you for bringing the APVMA reference to my attention. If the SILICON CHIP staff consider that the Cu/Ag sanitisation is too problematic to be featured in the magazine, fair enough, say so, but please don't over-simplify; that just adds to the flood of misinformation threatening to drown us all.

I have no connection with any promoter of such products, apart from use of one of these systems, which I purchased 20 years ago. I have found that chlorine to at least the minimum recommended level is necessary when the pool is in use and "normal" chlorine levels are necessary when the pool is being used by multiple people. However, the Cu/Ag keeps the pool reasonably clean without chlorine, when the pool is not being used.

The APVMA article does not discuss the issue of the persistence in solution of Cu/Ag ions versus chlorine but its website shows the product I use as registered "For the control of algae in swimming pools and spas".

Would I recommend such a system? I have been asked just that question by other pool owners and people contemplating getting a pool, all of whom seem to have been attracted by the "no chlorine" spin. My answer has always been highly qualified because my experience has been that the system I purchased did not meet my expectations but it did have some effect which I judged useful for me, there are many factors to consider and I could not find accessible, comprehensive explanations as references – no thanks to the pool industry on that.

So far as I am aware, none of those who asked my opinion subsequently purchased a Cu/Ag ioniser.

SILICON CHIP often carries articles with a technical focus other than pure electronics. Perhaps you might even consider a technical article on aspects of the use of electronics in sanitiser products. If the promoters of these products are willing to engage in demonstrating that the products are useful and discuss their limitations with a respected technical journal, this would be an opportunity to increase their credibility, rather than just relying on the usual lifestyle magazine advertising hype. If not, then that speaks for itself.

Peter Bennett,
Macarthur, ACT.

Taxpayers paying dearly for solar power

I refer to your Publisher's Letter, "Australia's Energy Needs in the Hands of the Clowns" in the January 2012 issue and agree with all of the points you made.

As a retired professional engineer (electrical and mechanical, and incidentally I also am licensed amateur VK6AFA), I have been concerned for some time about the apparent lack of engineering expertise available to our politicians (State and Federal) when considering energy issues and have communicated my thoughts and concerns directly to the appropriate ministers.

As a young engineer in the late 1950s, I remember the efforts of the IE Aust. to get the government interested in a national energy policy but such a policy has never got off the ground, partly because of Australia's great distances and also interstate rivalries. My main concern is the huge disconnect between most lay persons in Australia (and most politicians) and the technical basis of much of their day-to-day lives.

For example, a young mum gets into her high clearance 4WD to take her child to day care and she (and probably her partner) has no idea what labour and materials have been involved in producing it and what goes on under the bonnet. In addition, she (or he) has no idea that continuous electric power is required to ensure that people can live their urban lifestyle.

At another level, I recently moved into a house in Perth and the previous owner (a school administrator) had put in a nominal 1kW solar panel installation to feed power back into the mains. He gave me all the papers and I was staggered to find that the system was quoted at $11,000 (July 2009) and that there had been a government rebate of $8000. The installer gave a discount and the outcome was that the system cost the householder nothing and the government (taxpayer) $8000! Are we going mad?

John Farnan,
Tuart Hill, WA.

Few politicians have any technical knowledge

I always look forward to Leo Simpson's Publisher's Letter. Leo often comments on current social issues that have a technical flavour, such as January's offering about Australia's energy needs.

Leo assumed that a 329-page report put together by, one must assume, informed people with qualifications, experience and a desire to come up with a technically sound result would do so. Well welcome to the real world. I have lived long enough to have become cynical about how much of the world works. We live in an ever increasing technical world that is "run" by politicians and others who actually know little about what they are responsible for.

How many of our politicians come from a technical or engineering background? Most are lawyers, and business people or come from a union background. The end result is that these senior bureaucrats and politicians make decisions about serious technical issues they know little or

Mailbag: continued

Confounding the printer consumable strategy

I have several laser printers which I use for work purposes. They are of the "close male relative" variety but I am guessing that my gripe will relate to other brands too. They fall into the low-end budget category and were chosen because they are small enough to fit under the work bench.

These printers are factory-programmed to decide when they have run out of toner. At that point, a "toner" light comes on and the printer refuses to print any more pages. Up until this point the print quality has been very good.

Now I know from experience with older printers that substantial visible deterioration in print quality can occur before the toner is exhausted. Furthermore, with the older printers, removing the toner cartridge and giving it a shake could rejuvenate it for a while longer but not so with the later generation printers. When the toner light comes on, nothing less than a "new" cartridge will satisfy the printer.

The toner cartridges in question all have a gear on the side which is wound through an arc when the new cartridge is inserted into the printer and this gear presumably trips a switch which tells the printer a new cartridge has been installed. The gear then remains in its "already installed" or "old cartridge" position so the printer can tell that the cartridge is an old one if it is reinserted.

By removing two or three screws and the end cover of the cartridge, this gear can be reset to its "new" position and then the printer will accept the cartridge as new. Printing will then continue with excellent quality. I have found in my situation that the printer will report a dead toner cartridge about every 2-3 weeks and by resetting the cartridge I can extend its life by 4-5 times before the print quality suggests that it really is time to replace it.

A similar situation exists with the drum unit. The printer also will advise you when you need to install a new drum. With my printers, there is a switch sequence which resets the printer to tell it that it has a new drum. This information comes with the new drum and is part of its installation procedure but it can be applied to old drums too, to extend their useful lives. As with the toner, the drum life is much longer than the printer would have you believe.

Surely with all of today's sophisticated microelectronics, the printer manufacturers could devise a more accurate way of telling when the toner is genuinely running low or the drum unit really is worn out, or they could even be satisfied with the time-honoured system of waiting until the print quality makes it obvious that a new toner cartridge or drum is needed.

With respect to the same printers, I have found that the consumables, ie, toner cartridges and particularly drum units, are disproportionately expensive. A replacement toner cartridge costs at least half as much as a new printer with toner included.

However, a replacement drum unit costs more than a new printer which comes with a drum unit and a toner cartridge. When it is time to replace the drum unit, and the printer will certainly let you know when it thinks it is time, it is more economically sensible to buy a new printer rather than a new drum, but only if resetting the printer and continuing with the old drum does not rectify the problem.

The practice of extracting profits from consumables might be good for business but it is not environmentally responsible.

Robert Allan,
Hunter's Hill, NSW.

nothing about. Their decisions are more likely to be based on getting themselves re-employed or re-elected or just to be seen to be "doing something".

Even dealing with smaller issues, like poor mobile phone coverage, shows how the very people you expect to have a knowledge of their field can be most disappointing. I complained about poor mobile phone coverage and after two years gave up. I had a total of five Telstra case managers and two team leaders, all of whom showed an appalling lack of understanding of mobile phone infrastructure.

Among many things I was told that our local phone tower was not turned on, had no antennas on it and did not have an antenna pointing at us – just for starters. I offered to send a photograph of the phone tower but was told by one case manager he did not know what a phone tower looked like.

William McGhie, VK6UU,
Gooseberry Hill, WA.

VOX relay solved TV thump problem

I just wanted to thank you for presenting the VOX relay kit (Silicon Chip, July 2011). I had a situation where several minutes after switching off my LCD TV, I would get a huge DC thump from the external powered 2.1 computer speakers I'm using with it (the internal ones are very ordinary).

Previously the only solution was to switch off the speakers to avoid the bang but this circuit has helped tremendously.

A couple of compromises had to be made though. Changing the 1kΩ resistor leading from VR2 to about 130kΩ meant I was able to adjust it to a much longer delay time. I have it set to about two minutes to avoid unnecessary switching during short pauses in audio. Also, in order to prevent the circuit triggering when the DC thump arrives, I installed a small, el-cheapo DAC and used the optical output from the TV to supply the audio to the VOX circuit. It all works a charm; no DC thump at switch on or off.

You may ask, why I didn't just feed the optical output from the TV to a DAC and then to the speakers and be done with it? The reason for this approach was that the optical output level is fixed and we wanted to change the volume with the TV remote. That's possible only by using the analog outputs from the TV.

Luke Biddle,
Currumbin Waters, Qld.

Video steps of any disassembly for later use

Here is a suggestion that fits into the "for what it's worth category".

Many times, I've heard writers refer to taking photographs, making sketches, etc to help them to re-assemble some device that needs to be pulled apart for repairs. This is especially true of laptop computers that seem to have a million little screws that are nearly, but not quite, the same length.

Well, nowadays we have something better. We have miniature video cameras in every type and size imaginable, and for trivial money. I have a little unit that I clip into my pocket and it does a great job of recording every step of disassembly and perhaps just as importantly, where I put the parts once I take them off!

I can even do nice things like film myself running each removed screw or bolt through a vernier calliper so that I know exactly which screw fits where.

Reassembly is then a rewind of the disassembly procedure!

Nenad Stojadinovic,
Gunning, NSW.

Commercials are loud because of compression

I would like to revise what Leo Simpson had to say in "Publisher's Letter" on volume levels being increased for commercials, as his statements are not precisely correct. Don't get me wrong; to the listener or viewer it definitely sounds louder.

Years ago, I was employed by Radio 2SM in Sydney, as a Broadcast Technician and there were no FM stations, only AM stations. 2SM was "top of dial" in Sydney but had the worst propagation because of its frequency (1270kHz). What was done by the engineers was to employ compression technology (Automatic Gain Control or AGC), thereby increasing its relative loudness but not volume.

The modulators in any transmitter must not exceed 100% modulation depth as this will create spurious emissions. I know modulation depth applies to AM transmitters but the same is also true to FM transmitter programs. By using the compression technology (AGC), the volume is not increased but the modulation depth percentage is increased and this is what is done to commercials. An example of this was Phil Spector's "Wall of Sound".

An increase in the percentage of modulation depth is explained by maintaining a more constant signal with smaller excursions on the VU meter; most broadcasters maintain the percentage of modulation at approximately 60%. 2SM increased their depth percentage to approximately 80-85% by using compression technology (AGC).

You can check this for yourself by applying a proper VU meter to the signal and monitoring the volume level which you will see does not increase but the percentage of modulation

Clarification on grid-feed inverters

Regarding the discussion on grid feed-in solar panels, there is a small technicality to be noted. Power is not fed into the grid by increasing the inverter voltage level above the grid level. To deliver power, the inverter must be actually trying to increase the frequency.

Assuming that the grid load remains constant, some other generation on the system then has to back off by the amount of power that the inverter is supplying, or else the frequency would rise. The local voltage at the inverter feed-in point will, however, rise slightly but that is because the main power stations have to supply less generation to the inverter locality, and the voltage drop between the grid generation and the inverter connection point reduces.

The effect of pushing volts into the system at the same frequency only changes (usually improves) the system power factor. Bearing in mind the scale of the grid generation relative to the inverter output, the changes to the grid conditions at the inverter feed-in point are ordinarily minuscule. However, with either a very small or weak system, or a very large inverter, the effects can be noticeable.

Don Brown,
Beachmere, Qld.

Solar power does not reduce peak air-conditioning load

Brian O'Neill (Mailbag, February) says that, on average, the effect that a rooftop PV system has on the electricity network is positive. That's true in the same sense that if I fire two shots, one completely missing the target on the left, the other missing it on the right by the same amount, on average I've scored two bulls-eyes.

In a hot country like Australia it is not true that PV generates its maximum output at the time of peak load on the electricity grid. No matter how many times the greenies repeat that line, it doesn't make it true. It generates its peak output on cool clear spring and autumn days when no-one's at home with their air-conditioning running and there's very little load on the network in the PV-roofed affluent suburbs to soak it up. That's when over-voltage and inverter shut-downs occur. That's the shot that misses the target on the left.

More air-conditioning is what is creating the ever-increasing peak load. The rule of thumb I understand is that for every $1000 worth of air-conditioners people buy, the electricity companies have to invest another $1000 in plant. And in the time overall electricity usage has increased 30%, peak load has doubled. It occurs at 2-8pm after a few very hot days, one after another, as people get home and turn on their air-conditioners to cool their stinking hot homes. Then their TVs. Then their stoves.

On those days, PV panels are already far over their rated optimum temperatures by the middle of the day and producing reduced output. By about 4-5PM, no matter how many roofs have PV on them, it is producing virtually no output because the sun is too low in the sky. That's the shot that misses the target on the right.

Is rooftop PV good in that it reduces CO_2 emissions and reduces the power bills of the few who have it, including me? Yes. Does it reduce the ever increasing peak load on the network caused by air-conditioners, and the huge investment by electricity producers in generating plant that only gets used a few hours on a few days a year and pushes our power prices up? No.

We need ways to reduce and time-shift that peak cooling load; eg, by restricting air-conditioners to cooling to 24°C or even 26°C and not to a silly and unnecessary European 22°C. The figure I've heard is that every 2°C increase halves the size of the air-conditioner required and the power it uses. Or how about timers on office air-conditioners so they turn off well before knock-off time rather than waiting until everyone is long gone. Or using a freezer unit that uses phase change to create and store a lot of cold overnight and release it during the day.

If the evening was cool enough this might be enough for the unit to use virtually no power. If power was required, it would be consumed when the temperature gradient the heat pump was working against was smaller, the network load was lowest and price of the power lowest.

A unit based on available chest freezers couldn't pump enough cold during the few hours of the early morning. A split system air-conditioner that could still cool during the day if required and which used the previous evening to store cold and release it to cool your home before you were due home would be ideal. It could even check on the internet for a forecast hot day the next.

That's what we need; discussion of potentially constructive effective ideas to cut power bills and CO_2 emissions, an informed public that's told what they can do and government pressure to force the lazy to do it, rather than mindless defence of fashionable gimmicks.

Gordon Drennan,
Burton, SA.

depth is greater during an ad break. During a program that is broadcast, the excursions of the VU meter are quite pronounced but when the commercials come on, the VU meter will have much smaller excursions.

One of the drawbacks for 2SM was that the modulator output valves, which were being driven harder by the percentage of modulation depth increase, had a somewhat reduced life. At several thousand dollars each (two were required), this was an expense that 2SM had to bear to gain the increase in propagation.

This is why when you approach a radio or TV broadcaster about sound level increase during commercials they will emphatically deny that they increase the volume, because they don't. But as I said, the commercials are recorded at a greater level of percentage of modulation depth by the use of compression (AGC).

Neil Davis,
Stokers Siding, NSW.

Comment: all of what you say about compression is correct but if the net result is that the average modulation level on commercials is higher than on the normal program, does that not mean the commercials will, in fact, be louder?

18-bit DAC circuit is not valid

On page 61 of the January 2012 issue, you published a circuit for an 18-bit DAC.

It is my opinion that while the circuit could theoretically work as described, it has significant shortcomings that would render its implementation pointless. The basic problem is that you cannot make an 18-bit DAC with 18-bit performance from two DACs of lower performance; linearity and precision being the main concerns.

The difficulty arises from the requirement for resistors of a wide range of values with a tolerance better than the relative value of the Least Significant Bit. For an 18-bit system, that means a resistor tolerance of 0.0004%. Resistors of 0.01% are available for less than $5 but only for a few values.

Of course, it should be possible, theoretically at least, to trim the resistor values to those required but I suggest that that will be extremely difficult.

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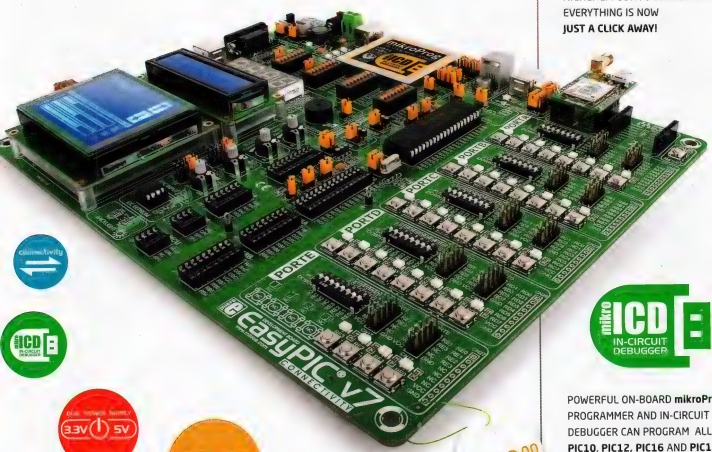

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Mailbag: continued

Smart grid research may help with peak loads

All grid-connected inverters approved for use in Australia must have under/over voltage protection so that they will automatically disconnect from the grid. During 2010, I had observed that my solar system disconnected from the grid on a number of occasions. On some sunny days, two or three disconnects occurred and lasted for approximately 30 minutes.

Since my system has extensive data logging I decided to look at the data to see if it agreed with your editorial statement, in the December 2011 issue, that solar systems will increase grid voltage and lead to grid instability.

Surprisingly, these disconnects had nothing to do with the average grid voltage being too high; in fact for approximately 30 minutes before the disconnects, the voltage was reasonably constant and well within the voltage limits specified in AS4777.3. I log the data at a 1-minute sampling rate.

I was aware that a number of my neighbours had installed solar systems in this period (one with a 10kW capacity) and they also were experiencing automatic disconnects. I suspected at the time that the supply authorities were forcing the disconnects by putting a short voltage pulse on the line so that they could balance the power they had forward committed themselves to and the demand.

This suspicion has been further supported by the fact that in 2011/12 I have not observed any disconnects on my system. I suspect the energy retailers suddenly realised that it was more economic for them if they used all the solar power that was available, especially in NSW where most of them pay nothing for that power and then on-sell it to the consumer at a premium since it is green power.

In fact, at the peak time in the afternoon in Summer they can pay of the order of $1 to $2 per kWh to the power stations for their electricity (see AEMO website).

Another point that should be made is that most universities around the world with a reasonably-sized Electrical Engineering Department have very active "smart grid" research programs under-way. These programs are using Distributed Control Theory to develop intelligent grids that will improve the stability and more importantly the security of national grid networks.

One of the key elements in the implementation of this research is the recognition that solar and wind systems will become more widespread, resulting in a distributed generation system which will be more stable and less prone to large scale blackouts.

So rather than domestic solar systems making electricity grids unstable as your editorial stated, they are one of the catalysts that will ensure a more stable grid in the future.

Some comments about grid voltages variations are also appropriate. The data logged from my system shows grid voltage variations from 228V to 264V and surprisingly the higher voltages often occurred during the evening when no solar generation was occurring. Similarly the lower voltages also occurred during the day when maximum solar power was being generated.

I suggest that James Goding's letter in the January 2012 issue of SILICON CHIP, stating that "feed in" from solar panels may be the cause of his halogen lamp failures, is incorrect. If a product fails because it cannot work within the standards set for our electrical network it should not be allowed to be sold and he should make sure that the retailer is aware of this.

Finally, if the most sceptical climate change person considers that there is a small possibility that climate change is occurring, then if that person is rational they should be supporting renewable energy programs irrespective of their political bias. This is especially the case with solar PV systems when such systems have been demonstrated, even without government subsidies, to be economically viable (see my letter in the November 2011 issue) at the current retail price for electricity.

Dr R. D. Bell,
Glenorie, NSW.

Comment: few people would argue that climate change is not occurring. However, there is considerable debate as to whether or not global warming is occurring and if it is, whether human activity is the main factor. Whatever the truth of the matter, it does seem that the previous extreme predictions from climate activists are now being seriously challenged.

For example, the 2kΩ resistor from P17 would need to be trimmed to within one hundredth of an ohm in value.

Even if one were able to trim all the resistors to the required value there remains the problem of temperature coefficient. The resistors I mentioned above have a temperature coefficient of 15ppm, so a temperature difference between two critical resistors of merely one third of a degree C would destroy any claim to 18-bit linearity.

It is also usual for resistors of the same type but differing values to have differing temperature coefficients.

It is precisely for the above reasons that current-mode DACs are popular, as they are easier to manufacture and usually cheaper.

The accompanying write up says that "the microcontroller can calibrate the DAC by turning on each output in turn and measuring the output step" which again is theoretically true but impractical. It would require an 18-bit ADC (at least) to achieve 18-bit calibration accuracy and would have to be done regularly to ensure that minute changes in temperature have not pushed the DAC out of calibration.

Given the difficulties of delivering anything much better than 8-bit performance with this approach and the ready availability of 16-bit DACs for less than $35 (and a 16-bit DAC soon to be available from Element 14 for less

than $15 in one-off quantities), I am of the opinion that this proposal has all the practical value of the 3-diode full-wave rectifier that a friend from my student days was so obsessed with.

Phil Denniss,
Darlington, NSW.

Radio control for DCC installations

As a retailer of model railway equipment, I enjoyed reading your well-explained article on the development of DCC in the February 2012 issue.

In fact, the development of individual locomotive control has progressed further than your article explains and I would refer you to our radio control Stanton S-CAB system for use on existing DC layouts. The main feature of this product is the ability to allow an analog DC railway modeller to experience the advantages of DCC without modifying or changing their DC model railway layout or buying a DCC base station.

The initial package of the Stanton S-CAB consists of a hand-held R/C transmitter, an R/C receiver, a DCC decoder and a USB charging cable for the battery in the transmitter. It conforms to the NMRA standards and the transmitter is only active when transmitting instructions, thereby reducing RF interference.

After installing the R/C receiver and DCC decoder into his favourite engine, the DC railway modeller simply sets his DC controller to around 12V to supply the installed receiver and DCC decoder. All commands are made via the transmitter using DCC standards and there is no need to purchase a booster or change any wiring.

Stage 2 of the Stanton S-CAB development is "on-board" power. Instead of using the track to power a locomotive, a lithium polymer battery is installed in the loco in addition to the receiver/decoder. This self-contained unit does not rely on the track for either power or the transmission of signals. A charging section at a station or sidings is used to keep the battery fully charged.

Stage 3 of the Stanton S-CAB has the ability to add sound systems.

Peter Berg, Berg's Hobbies,
Parramatta, NSW.

Ignition coils are not positive or negative-earth

With respect to the item on the Ferguson Tractor Ignition on page 94 of the February 2012 issue, in 50 years of working on engines I have never heard of a negative or positive-earth coil. Nor have I seen one labelled that.

The actual EHT coil is not connected to the body of the coil. In order to confirm that I checked three I have here. The factory manuals I have for a tractor and ute do not mention the coils having "polarity", in respect of the chassis.

It is quite obvious that what is important is that the polarity is correct as that would control the spark polarity. In the case of the "grey ghost", the coil positive should in fact go to the circuit breaker and both my (positive earth) 1951 TE-D and the 1958 Mk.II ute are wired that way (both coils are old). The last ones to fail suffered insulation breakdown on the tower (flashover), which happened on both our AP5, which is negative earth, and the ute. That to me is a more an insulation quality/age issue and not uncommon.

Marcus Chick,
Wangaratta, Vic.

Comment: it is true that coils were never marked to indicate polarity but then we did not say that. And you are correct in stating that neither side of the coil is actually connected to the case.

Perhaps we should have added the comment that when using a coil designed for a negative earth vehicle in a positive earth situation, then the low voltage coil terminals should be swapped. In other words, the coil terminal marked CB (circuit breaker) or "–" should connect to +12V and the positive terminal of the coil should connect to the points.

This then gives correct spark polarity but does subtract the coil primary voltage from the overall voltage delivered to the spark plug. All of which is more or less academic if the substituted negative earth coil works in the positive earth vehicle.

Operating DCC-controlled trains using a PC

It was interesting to read your article on DCC for Model Railways in the February 2012 issue. Model railways have always been a hobby that I have enjoyed most of my life, even from a very early age. The first electric train set I ever had was a 3-rail Trix Twin system on which you could run two trains on at the same time. How things have progressed over the years.

On the subject of DCC, I think there was an Australian back in the 1980s

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Mailbag: continued

Passing on electronics knowledge to younger generation

As well as being an avid SILICON CHIP subscriber I am a member of a local computer club: **http://www.ddcclub.org/** I am using the club as a venue to generate an interest in electronics with the local game-addicted youth, by showing them basic kit building skills.

With the assistance of several boys, I have just built the Ultrasonic Cleaner (SILICON CHIP, August 2010) using a 10-litre chemical drum. I carefully cut the centre out of the lid so that the transducer could be held with its face sitting in the water. I used the washer from the lid to seal the edge of the transducer.

The boys were most impressed with the performance of this unit, and enjoyed watching particles being "jerked" through the water. They are now keen on building the Solar Tracker unit described in the Circuit Notebook pages of the January 2012 issue of SILICON CHIP.

A talk I give is that the modern world is built on electronics yet 95% of people have no idea how it actually works. It is pretty cool to be able to look at a piece of technology and understand how it works. I give the example of a CD player and explain how it works. That usually impresses them.

Chris Ryan,
Dubbo, NSW.

who came up with some sort of DCC system but was found to be not very successful. In the last few years I have managed to convert most of my locos (Fleischmann, Roco & Liliput) to DCC running and have never looked back.

Of even more recent days I have been in the process of programming and operating my trains and layout via a PC system that I came upon at a recent exhibition in Victoria. It can be found at **www.jmri.sf.net** The system will also allow you to operate trains via a smart phone.

Trevor Butler,
Hadfield, Vic.

Simple crock-pot temperature controller

Your correspondent with the crock-pot problem (Ask SILICON CHIP, December 2011, page 106) could perhaps do what I have done for mine and my father's appliance.

I obtained a lamp dimmer (400W Arlec 9021 or similar) and mounted it in two power block supports, one 12mm thick and the other 36mm thick. Take a 2-metre extension cord, cut it in two and wire it into the lamp dimmer. I chose not to use the on/off switch but I did use the terminals to terminate the various leads which were securely anchored.

I now have complete range of control from full on to full off. Set the pot to low range and the dimmer to half way and you now have total control. I have been using this for several years now and I am very happy with it.

Malcolm Keech,
Seacliff Park, SA.

Reactions to the February 2012 issue

In response to the Publisher's Letter regarding the new CALMA legislation (I had to check to see it wasn't April when they made that up), try reading it; it won't "really" limit advertisement volume level – it only regulates what is currently acceptable in an otherwise mostly unregulated realm. The odd advert that IS limited due to this act will most likely be changed due to viewer complaints anyway (as some super-loud adverts are here). In other words, nothing is going to change.

In response to "Simon Kareh" in Mailbag on page 4 of the February 2012 issue, TV4ME is an almost 24 hour per day infomercial channel. By "almost", I've noted some episodes of "Psychic TV" which many would consider of equally, ahem, dubious nature. So the question begs to be asked, If you can't receive the channel now, why would you still want to?"

Lastly, since dragging ourselves into the 21st century kicking and screaming by purchasing our very first digital television set last month, I can only say that it has completely ruined my TV viewing experience. I watch a program until an advertisement appears, press mute, flip channels to something else, un-mute, and watch that; repeated as required. I haven't watched an entire episode contiguously since then.

But then again, perhaps I've been spoiled rotten by having a personal computer attached to the TV, networked to the file server that now holds my entire collection of DVDs – what I want, when I want, with no adverts, of course.

I understand that advertisements pay for what we're watching and that's great but why is there an entire ocean of annoying adverts, with only a mere drop of genuinely funny, witty or unique ads that one not only wants to watch but talks about as well?

John Tserkezis,
Croydon Park, NSW.

Loudness is only measured in decibels

In your February Publisher's Letter about volume levels in TV ads, it was surprising that in a technical magazine you wrote simply of loudness, with no reference to the way that perception of loudness can be manipulated by audio processing.

It's not the volume in decibels but the nature of the sound that can make it seem more penetrating. Thus the

inviting notion that the wicked network control operators deliberately crank up the ads on transmission is probably false.

So you're watching a tele-drama in which actors, speaking in normally modulated voices, are picked up by an overhead (boom) mike some distance from their mouths, so their voices are a bit on the thin side but natural. Suddenly we cut to an ad and there's a voice recorded very close to the mike, its upper mid-range boosted by an equaliser and the whole thing pumped up by a compressor so that all the spruiker's syllables punch the ceiling of the decibel scale.

So of course the ad sounds so much louder than the program, yet the peaks on a dB meter would probably read the same, except for being naturally spaced on the program but almost continuous on the ad. This example may seem a bit extreme but is far from unusual.

The effectiveness of frequency band shaping can be experienced even away from the TV ads. Haven't you winced at the ear-piercing insert of a telephone-sourced interview in the TV or radio news? Yet no doubt on a level meter it would peak the same as the newsreader: it's the rasping treble emphasis (which hardly affects a meter) that makes it so harsh and penetrating. I was able to observe this recently when I set up to record from Classic FM: if anything, the raucous telephone voice peaked lower on the meter than the newsreader.

Good luck to any well-meaning regulators, surely they can only legislate in terms of decibels on meters and if my (perhaps slightly paranoid) rant above holds even partly true and viewers/listeners complain of excessive ad volume, the networks could carry on as before while piously pointing to their dB meters. How can anyone draft legislation for a subjective thing like perceived loudness?

Brian Wallace,
Dora Creek, NSW. SC

TV4ME's use of MPEG4 violates DVB-T spec

You may be aware that there is a new digital channel called TV4ME broadcast by Channel 7. This channel uses MPEG4.

I remember reading in the past that the BBC (a DVB-T broadcaster) wanted to use MPEG4 for their HD broadcasts but they could only use MPEG4 if they used DVB-T2. This means the use of MPEG4 under DVB-T is a violation of the DVB-T specification (and is therefore not permitted) unless they use DVB-T2, with the only exception being 3DTV.

For satellite, MPEG4 is allowed when DVB-S2 is used but the use of MPEG4 under DVB-S is allowed only if there are technical issues with the satellite or its owner. If MPEG4 is proposed as (or has become) an Australian Standard, it needs to be amended to include DVB-T2, along with including audio standard Dolby Digital Plus.

This standard could also be called Freeview Plus.

Bryce Cherry,
Rockhampton, Qld.

A vision of factory farming in the 21st century

Vertical Farms

By LEO SIMPSON

Planet Earth now has seven billion hungry humans to feed. How will we feed the increasing hordes in years to come? Arable land is decreasing and higher yields are harder to obtain. This Australian technology may provide part of the solution, combining bioponics, LED illumination and computer control to deliver quality food in rapid time.

How many readers think that you need ultraviolet light to sustain photosynthesis in plants?

After all, whether they use sunlight or artificial illumination, greenhouses inevitably expose their crops to ultraviolet radiation.

Well, it turns out that UV is not necessary. To sustain photosynthesis and growth, plants only need red and blue light. They don't need green light either; they reflect it, which is why plant leaves are green!

And they certainly don't need ultraviolet; too much UV causes sun-burn to plants, just as it does with humans.

So it transpires that the artificial light needed for plants grown in greenhouses can be simply provided by high intensity red and blue LEDs. But why would you want artificial light anyway? Why not simply use the Sun?

Well Ol' Sol is fine for traditional land farming but we're talking about much more intense cropping – the factory farming of the future.

Actually, there has been a lot of research into the use of artificial light for photosynthesis.

A superb crop of basil after just a few weeks growth in the Vertical Farm. Not a single bug (or any leaf damage!) to be seen . . .

In fact, plant biologists refer to photosynthetically active radiation (PAR) as light ranging in wavelengths from 400-700 nanometres, precisely what can be sourced from LEDs and since plants largely reflect green wavelengths, we are only interested in red and blue LEDs.

Photosynthetically active radiation (PAR) is usually measured in micromole photons per square meter per second (μmol photons/m^2/sec); one micromole being one-millionth of a Mole.

A mole of photons is the same as Avogadro's number: 6.02×10^{23}. And it just happens that photosynthesis is directly proportional to the number of photons falling on the plants: about nine photosynthetically active mole photons is required to produce one mole of oxygen, the product of photosynthesis.

Incidentally, there is also quite a lot of current research into artificial photosynthesis, ie, where no plants are involved, just micro-organisms. For the purpose of this article though, we are interested in artificial illumination for use in green-houses.

We should also define the term "bioponics". This is different from hydroponics in that the nutrient mix contains biologically active micro-organisms. The micro-organisms are crucial in enabling the plants to take up all the vital nutrients. Without the micro-organisms, hydroponics can be very much a hit-and-miss process.

Greenhouses waste a lot of space

While greenhouses and hydroponics can greatly increase crop yields, greenhouses themselves are not very space efficient. For a conventional

Here's a complete Vertical Farm, taken with a crop growing and the LEDs illuminated. The containers in front hold the nutrient solutions (with their pumps); the cabinet alongside contains the computers and electronics to drive it.

Another, view of the Vertical Farms' XT432, which can hold up to 23,760 plants growing much faster than they would using normal farming methods.

greenhouse, up to 60% of the available space is needed for aisles so that humans can get access to all the plants.

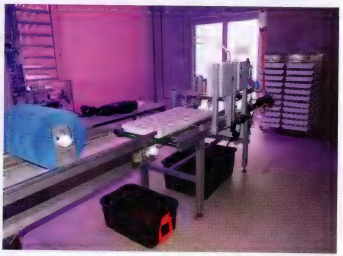
Enter . . . Vertical Farms

Here is where the Vertical Farms concept comes into play: instead of growing plants on one level, it can be done on many levels. As the photos show, this is no longer a greenhouse; it is a large module with plants growing on 12 levels, spaced with about 400mm between them.

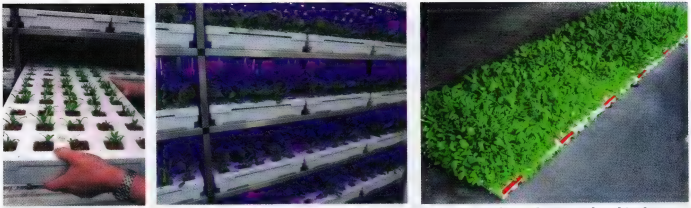
With the plants growing on so many levels, artificial illumination is mandatory and this is where the high intensity red and blue LEDs enter the equation.

Each plant tray is exposed to high levels of red and blue light for between 12 and 17 hours a day and subjected

The start of the process: the white plastic trays are filled with reusable growing medium (not soil!). Most of the photos in this feature were taken "in situ" with the Vertical Farm operating, hence the magenta-like tones.



While no medium has yet been placed, this shot shows how it is levelled off with the large blue wheel brush, ready for planting. The seeds are dropped onto the dry medium, watered and the trays then placed in the Vertical Farm.



Various stages of the growth cycle: after the spinach seeds are sown into the growing medium, the trays placed in the 12-level Vertical Farm so that their roots can soak up nutrients periodically flooded through the system through the watering system (patent-pending). They are irradiated by red and blue high intensity LEDs for up to 17 hours per day to finally produce the crop at right. No pesticides are needed because there are no pests!

to a carefully designed growth cycle with all the liquid nutrients supplied at optimum levels, under computer control.

This very long "growing day" and optimum levels of nutrients means that the time from initial seed planting to harvest is very short; just 21 days. And not only is the turnaround very short but the crop yields are much higher than can be obtained by any other means.

The plants are in a temperature-controlled environment and have no exposure to pests. No pesticides or herbicides are required. This is true "organic" agriculture (although we hate the term "organic"). In fact, since the plants are not handled at any time, so they do not even require washing.

And if the distance from grower to customer is short, no refrigeration is required either.

So that's the concept: factory farming in the truest sense, not subject the vagaries of weather or climate, soil fertility, pests, competition from weeds and so on, with optimum application of nutrients at the exact time the plants need it.

We hasten to add that this is not *just* a concept nor some elaborate scheme for future development. It is being used right now to produce fresh produce, as we saw when we visited the Vertical Farms factory, at Coolum Beach in Queensland. So let's fill in the details of this multi-level growing system.

XT432 Farm Block

This large module is 9 metres long, 2.1 metres wide and 3.9 metres high. It is fabricated mainly from stainless steel, with plastics used for all the piping, plant trays, lighting units and so on.

The module has a central aisle (shown on first page of this article) which gives access to the piping and wiring on all the levels, and after allowing for this aisle, the total growing area is 194 square metres, ie, about ten times the floor area occupied by the module itself.

Vertical Farms envisage that a typical factory farming installation would have maybe dozens of these modules, all networked to a central control system.

After allowing for access aisles for an elevating work platform (similar to those used by electricians when changing lights in buildings with high ceilings), a 2000 square metre warehouse could accommodate up to 55 of these modules, giving a growing space of 10670 square metres or just over one hectare. In other words, that is about five times the area of the warehouse.

And here's what they look like after just a few days of LED illumination from above and nutrient feeding from below. You can clearly see the banks of red and blue high-intensity LEDs above – they're so bright eye protection must be worn.

Speaking of nutrients from below, here's a view of the same trays at left lifted clear of the carefully-controlled nutrient medium. You can see how the roots emerge from the bottom of the trays in search of the liquid underneath.

Some idea of the scope and magitude of the XT432 Vertical Farm can be gleaned from these two photographs. The photo above is included to give some relativity of size, which is obvious when compared to the three people standing in front. Normally at this close range eye protection is mandatory to prevent eye damage.
At left just part of the growing racks and LEDs can be seen – each of the 12 (high) racks contains 36 growing trays and each tray contains 55 pockets containing individual plants. In this photo only a few racks are visible and even then, not all trays can be seen. This photo was taken before any medium or seeds were planted in that growing area.

By contrast, a conventional greenhouse with the same floor area would have a growing space of about 1000 square metres or less. So using XT432 modules would give ten times the growing space of a conventional greenhouse.

As already noted, there are 12 levels in the XT432 module and these are split into three bays, each of which is separately controlled and can therefore have different growing cycles.

Normally the same or a similar crop is grown in each bay since all bays use the same nutrient mix and lighting levels.

With the same crop in each bay, you can have the growing cycles each staggered by a week so that harvesting can be done progressively, week by week.

Such an installation with 55 XT432 modules could produce around 6.3 tonnes of leafy green vegetables, such as loose-leaf lettuce, spinach or rocket, per week. Over the course of a year, the output could be over three hundred tonnes. That's a lot of healthy green vegies!

There is no such thing as "seasonal" crops – you simply "dial up" the season needed to suit the crop and/or market demand.

Typically, if an operator wanted to grow a variety of different crops simultaneously, a number of XT432 module would be employed.

Each of the 12 levels has 36 growing trays, giving a total of 432. Each growing tray is illuminated by 32 high intensity red and blue LEDs, consuming about 51W in total.

The LEDs themselves were chosen after exhaustive tests to determine the best power to light ratio.

TLC for plants! With the significant amount of heat being generated, the high efficiency air conditioning system for the plants is also rather significant.

High light levels

It has to be said that the light intensity is extremely high and very uncomfortable. Anyone who is near the machine during its "daylight" hours for more than a short length of time must wear protective glasses to avoid the risk of Macular degeneration.

Each growing tray has 55 pockets which hold the growing medium; you can't call it soil. It is actually a red clay gravel into which the seeds are sown by machine.

The pockets are quite deep and they all sit in a lower tray which holds the water with all the nutrients. The nutrient mix is very complex and is not just a simple fertiliser solution.

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Instead there is a wide range of trace elements, including iodine and selenium, as well as a mix of microorganisms. In other words, the mix is biologically active, not sterile, as in normal hydroponics.

The nutrient mix is a proprietary product of Vertical Farms and an important factor in the overall success of the concept.

XT432 control system

The system is controlled by a main processor PCB with isolated I/O, analog inputs and PWM outputs.

The display interface is a Comfile Technologies colour touch panel. This allows the operator to select a crop species, start, stop and pause a growing cycle, check alarms and monitor water quality.

It also allows a simple pH and EC (electrical conductivity) probe calibration with a couple of touches on the screen.

Signals to and from the main control PCB are fed via a "buffer" PCB, which carries control relays that can be switched to automatic/off/manual, via on-board switches.

The board also takes care of fault detection and time delays etc to allow pump operation in the event of controller failure.

Manual/auto switches are also provided on the front of the control cabinet. The switches on the relay board are provided as a last resort.

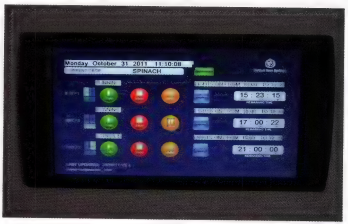
The main control PCB feeds PWM signals to a purpose-designed driver PCB which in turn controls the levels and colour ratios of the lighting. Each row of LED panels can be individually isolated.

The LEDs are fitted to strip PCBs which in turn plug into a main PCB, carrying PWM-controlled LED drivers for each colour.

Water quality and nutrient levels are controlled via a specially designed, isolated amplifier PCB that piggybacks the processor PCB. This allows dosing pumps to be run as required.

Two large pumps deliver nutrient-laden water to the growing trays according to a schedule dictated by the time of day, crop type and maturity. The pumps are 2.2kW single phase units, controlled by a FutureWave dual pump control (see the FutureWave review in the June 2011 issue of Silicon Chip).

The pumps only run for a few



While the touch-screen control panel can allow manual overrides, the system is very much automated and the screen is largely for information. Sensors built into the system will sound alarms on the manager's mobile phone.

The trays are then fed through a machine which looks like a mini car wash with large brushes and water sprays. They are thoroughly washed and sterilised using a hydrogen peroxide solution. Then the whole planting/growing cycle is repeated.

minutes every few hours and pump a load of nutrient through some special valves (patent pending) so they fill all the trays in a bay at once. The water then runs out of the trays into a big pool under the machine, which is constantly stirred by a circulation pump and its pH and EC are monitored and adjusted after each tray flood cycle.

Alarms are available for low and high water, loss of priming for various pumps and power failure. Alarms are routed to the display interface screen from the relay board via a Cubloc module and also to an SMS modem, which sends warning messages to the manager's mobile phone.

It also sends a message when a crop growth cycle is finished and needs attention.

With all those LEDs and pumps, the maximum power is about 9.5kW/phase (ie, 28.5kW total) but normally runs well under that, with the computer-controlled light periods.

Power consumption is typically 100kWh per day. Each XT432 factory unit requires a 415V 40A 3-phase connection.

And with all that power being dissipated, a big air-conditioning system is mandatory to control the overall temperature.

Planting and harvesting

Since the XT432 modules are essentially fully automated, the only time that humans are required on site is for planting the modules and harvesting. Both these processes employ specialised machinery as well.

For planting, the growing trays are run through a machine which fills each pocket up with the growing medium (red clay gravel) which is then levelled off with a large rotary brush. The seeds are then sown into all the pockets in the growing trays which can then be loaded into the bays in the XT432 modules.

At harvest time, the growing trays are removed from the XT432 and fed into a machine which lops off all the crop. The output is then packed immediately for distribution to supermarkets or restaurants.

The growing medium is then emptied from the trays and the gravel and root mass is separated into a hopper. It can then be composted or used as soil top-dressing.

The trays are then fed through a machine which looks like a mini car wash with large brushes and water sprays. They are thoroughly washed and sterilised using a hydrogen peroxide solution, then the whole planting/growing cycle can then be repeated.

All told, the Vertical Farm system is much more automated than typical greenhouse operations.

And while it may seem power hungry, it is no more so (perhaps a good deal less) than a greenhouse operation growing an equivalent amount of produce.

Will it become the factory farming system of the future? Only time will tell, but Vertical Farms are doing it right now and can show the world how.

Acknowledgement:

Our thanks to John Leslie of Vertical Farms Systems Pty Ltd (www.verticalfarms.com.au) and to Gary Smith, of GD Integration, (dms@southcom.com.au)

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by John (call me ET) Clarke

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Be sure to blend in amongst diabolical characters at your next interplanetary meeting. By building the Interplanetary Voice you too can sound like a genuine alien character with a metallically challenged voice. Use it to develop instant rapport with any such alien that you meet.

If you don't want to cause a faux-pas of interplanetary proportions (perhaps even threatening life on Earth as we know it), having a correct sounding voice is a prerequisite if you are communicating with one of the myriad of science fiction characters that originate from extraterrestrial planets. Many of these characters are encapsulated in a metallic suit and not surprisingly have a metallic sounding voice.

It is not uncommon for people on planet Earth to be aware of interplanetary aliens.

They will know of the Daleks who originate from the planet Skaro and the Cybermen from Mondas. These characters are often portrayed in the TV series Dr Who.

Undoubtedly, many will have heard (and for some the very last thing they hear) the terrifying and menacing phrase from the Daleks as they call out "exterminate, exterminate".

Other characters well known to the general public on the planet Earth include; the Klingons from Star Trek, Cylons from Battlestar Galactica and Darth Vader from Star Wars.

We will surely be exposed to more characters of this type as we come to explore more planets in the Galaxy and beyond.

One unfortunate characteristic of humans from the planet Earth is that they do not have the right sounding voice. Because of this, they are unable to communicate effectively with these interplanetary characters.

You really require a voice changer to convert a normally boring humanoid voice into a strongly metallic version. In this way your voice can be well understood with all manner of creatures you may encounter from other planets.

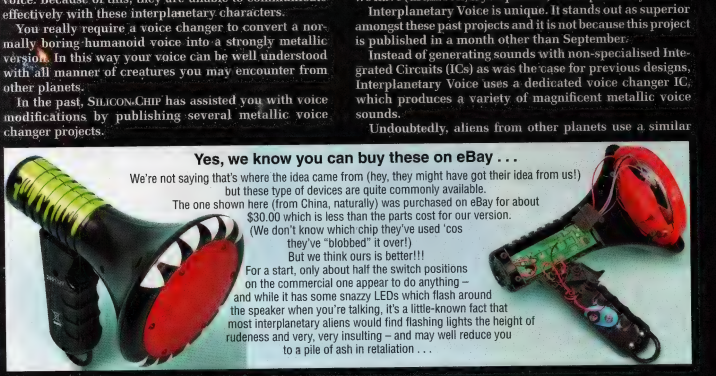
In the past, SILICON CHIP has assisted you with voice modifications by publishing several metallic voice changer projects.

There have been two "Vader Voice" projects, one in September 1988 and the other in September 1995. A "Galactic Voice" was published in September 2006 and now we have (drum roll, if you please!) "Interplanetary Voice".

Interplanetary Voice is unique. It stands out as superior amongst these past projects and it is not because this project is published in a month other than September.

Instead of generating sounds with non-specialised Integrated Circuits (ICs) as was the case for previous designs, Interplanetary Voice uses a dedicated voice changer IC which produces a variety of magnificent metallic voice sounds.

Undoubtedly, aliens from other planets use a similar



Yes, we know you can buy these on eBay . . .

We're not saying that's where the idea came from (hey, they might have got their idea from us!) but these type of devices are quite commonly available.

The one shown here (from China, naturally) was purchased on eBay for about $30.00 which is less than the parts cost for our version.

(We don't know which chip they've used 'cos they've "blobbed" it over!)

But we think ours is better!!!

For a start, only about half the switch positions on the commercial one appear to do anything – and while it has some snazzy LEDs which flash around the speaker when you're talking, it's a little-known fact that most interplanetary aliens would find flashing lights the height of rudeness and very, very insulting – and may well reduce you to a pile of ash in retaliation . . .

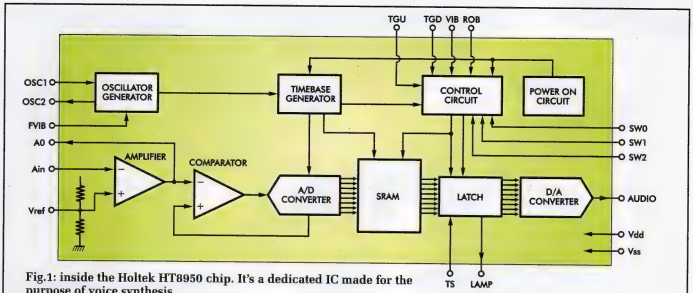


Fig.1: inside the Holtek HT8950 chip. It's a dedicated IC made for the purpose of voice synthesis.

voice changer IC. As we know, most ICs on planet Earth use a silicon-based semiconductor material but we suspect that the voice changer IC used by aliens is based on a semiconductor that differs from silicon.

Not to worry though, because the silicon version of the voice changer does the job just as well as any of the alien versions; in fact, without evidence to the contrary, it could even be better.

Interplanetary Voice is made in such a way that all you need to do is speak into it with a normal voice. Interplanetary Voice will do the conversion for you, producing a metallically accented sound via a loudspeaker.

Unique housing

Interplanetary Voice is housed in unique interplanetary-style "mouthpiece". If you are actually from Earth, you may note that it has a decided similarity to a flared loudspeaker port but this is purely co-incidental.

At the flared end is a small sound-producing device – again, earthlings may think this resembles a small speaker. The flare projects sound directly to an interplanetary alien's earpiece. Additionally, the flare and loudspeaker grill will imitate many a metallic voiced character's mouthpiece so you won't be mistaken for an Earthling.

Controls and microphone are mounted at the opposite end of the loudspeaker port. You can alter the volume with a rotary control and use pushbutton switches to set the voice effect depending on the characteristic sound you need.

There are Robot, Vibrato and Effects selections available. A power switch is included as well as a LED indicator. Additionally, a LED varies in brightness to show the instantaneous volume level of your voice.

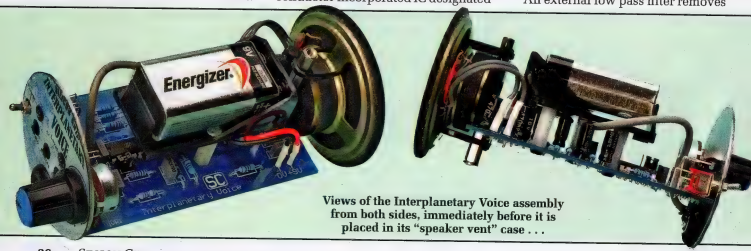
Block Diagram

The voice changer device used in Interplanetary Voice is the Holtek Semiconductor Incorporated IC designated the HT8950. This is fortunately available on planet Earth, though it does come from the alien land of Taiwan.

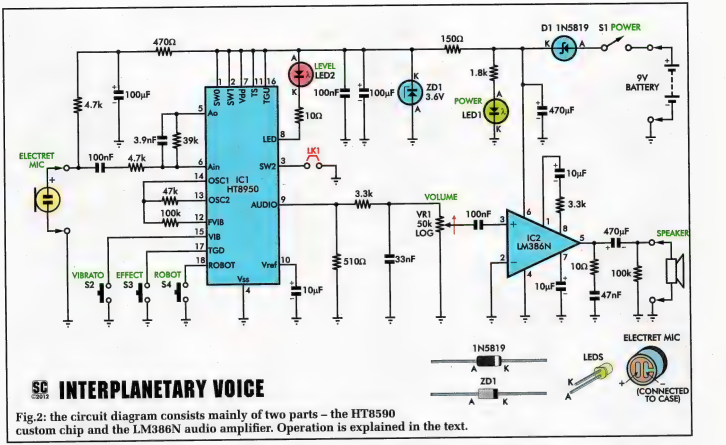
Fig.1 shows the internal arrangement for the HT8950 IC. Voice signal input is applied to the op amp. This has the non-inverting input tied to a reference voltage, allowing signal to swing above and below the reference. Both the inverting input and output of the op amp are available at the IC pins so that the op amp can be set up as an amplifier.

Signal from the op amp is converted to a digital value using an 8-bit analog to digital converter. An oscillator and time base generator set this analog to digital conversion sampling rate to 8kHz. The timebase also sets the storage rate of the digital conversion values into the static RAM. The latch presents and holds the SRAM values as they are clocked out and the digital to analog converter reconstructs the digital data to an analog signal.

An external low pass filter removes



Views of the Interplanetary Voice assembly from both sides, immediately before it is placed in its "speaker vent" case . . .



INTERPLANETARY VOICE

Fig.2: the circuit diagram consists mainly of two parts – the HT8590 custom chip and the LM386N audio amplifier. Operation is explained in the text.

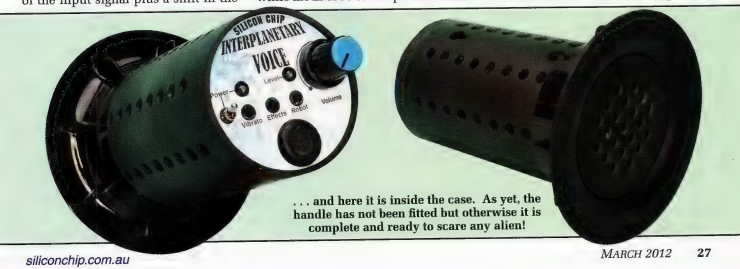
the higher frequency components from the digital to analog signal.

There is no information about the signal processing used to produce the voice changing. We do know that the input signal can be frequency modulated at 8Hz when the Vibrato is selected on the Interplanetary Voice. The Robot selection on the Interplanetary Voice appears to produce a ring modulator effect where the input voice signal is multiplied by another frequency (derived from the Time Base Generator) to produce sum and difference frequencies. This causes an upward or downward frequency shift of the input signal plus a shift in the signal harmonics. The modulation results in a metallic sounding timbre.

Inputs to the Control Circuit allow for variation of the amount that the ring modulation frequency shifts the input signal. Selection ranges from lower frequency shifts at a factor of 0.888, 0.8 and 0.66 to higher frequency shifts of 1.33, 1.6 and 2. These are selected using the Effects switch on the Interplanetary Voice.

The full circuit is shown in Fig.2. It comprises just two ICs; the Holtek HT8950 and an LM386 power amplifier to drive the loudspeaker. The HT8950 requires a 2.4 to 4V supply while the LM386 can be powered from the 9V supply.

The electret microphone is biased from a decoupled supply that uses a 470Ω resistor from the 3.6V supply, bypassed with a 100µF capacitor. A 4.7kΩ resistor provides the electret bias current. Signal output from the electret microphone is AC coupled to the op amp within IC1. This amplifier is set up as an inverting amplifier with the 4.7kΩ resistor for the inverting input and the 39kΩ resistor providing the feedback from the op amp output. Gain is about 8.3 and signal is rolled off above 1.046kHz using a 3.9nF across the 39kΩ resistor. Below 338Hz, signal is rolled off due to the 100nF capacitor



. . . and here it is inside the case. As yet, the handle has not been fitted but otherwise it is complete and ready to scare any alien!

and 4.7kΩ input impedance.

An internal oscillator for IC1 is formed by the 47kΩ and 100kΩ resistors at oscillator pins 13 and 12 respectively. Internal capacitance sets the frequency at 640kHz.

Control inputs for IC1 are at pins 1 through to pin 3 and from pin 15 to pin 18. Only pins 3, 15, 17 and 18 are used in our circuit. The unused pins can be left open due to internal pullup resistors at each input, but we tied these high to 3.6V on the PCB. Pins 15, 17 and 18 can be momentary connected to ground using S2-S4. These set the vibrato, effects and robot functions respectively.

Vibrato is toggled on or off with each press of switch S2. Pressing switch S3 cycles through the available frequency shift options for the modulator effects. Robot sound is selected with S4. It is deselected whenever there is a pressing of S3 to return to Effects mode. Vibrato can be selected as on or off in the Robot mode and Effects mode.

Tying pin 3 low using LK1 sets a normal sounding voice effect. This is regardless of the selections made with S2-S4.

A LED driver at pin 8 provides a variable brightness indicator of signal level received at the microphone. The LED modulates in brightness as you speak into the microphone.

The processed audio signal at pin 9 is an open drain connection (from the internalP-channel output Mosfet). A suitable drain load is provided by a 510Ω resistor connected to ground. The signal is filtered using a passive low pass filter comprising a 3.3kΩ resistor and 33nF capacitor. High frequency roll off is above 1.5kHz. Volume control is provided with VR1, a 50kΩ logarithmic potentiometer.

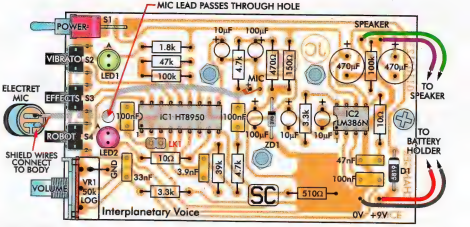


Fig.3: PCB component overlay, looking through the board from the non-copper side. Make sure that all components mount close down to the board surface.

The signal from the wiper of VR1 is AC coupled to IC2, the audio power amplifier, at pin 3. The inverting input of the power amplifier at pin 2 is grounded.

IC2 has a gain of close to 27 as set by the 3.3kΩ resistor and series 10µF capacitor between pins 1 and 8. Power supply is bypassed with a 470µF capacitor. The separate 10µF supply bypass at pin 7 removes supply ripple from the amplifier input stages. A Zobel network comprising a 10Ω resistor and 47nF capacitor prevents amplifier instability. The output of the amplifier drives the loudspeaker via a 470µF capacitor. The capacitor provides low frequency rolloff at below 42Hz for the 8Ω load.

IC2 can provide about 600mW into 8Ω with a 9V supply at 3% THD. Typical distortion is less than 0.2% below 200mW.

Power for the circuit is from a 9V battery using power switch, S1. Diode D1 prevents damage to the circuit with reversed supply. When supply is connected with the correct polarity, the low forward voltage drop of the Schottky diode gives extended battery life compared to when using a standard diode. Supply for IC1 is via a 3.6V zener diode (ZD1) and is fed current via a 150Ω resistor. The 3.6V supply is bypassed with a 100nF capacitor and a 100µF electrolytic capacitor.

Construction

Interplanetary Voice is constructed

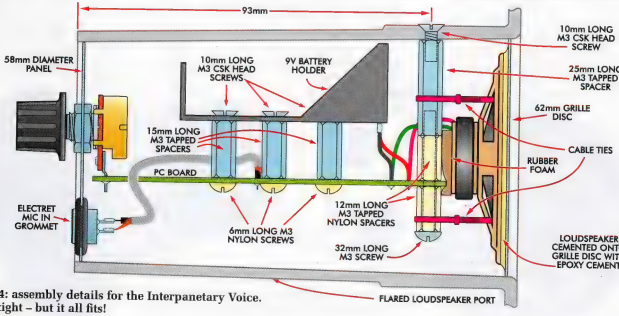


Fig.4: assembly details for the Interpanetary Voice. It's tight – but it all fits!

on a smallish (92 x 54mm) PCB coded 08102121.

The PCB is suspended within the plastic loudspeaker port and is supported at one end with the circular front panel that fits into the non-flared end of the port. The opposite end of the PCB is supported using a long standoff that is secured to the flared end of the plastic speaker port.

Begin construction by checking the board for breaks in tracks or shorts between tracks or pads. If you are building the unit using a PCB, this is most unlikely – readers have commented on the outstanding quality of our boards! But if you use another board and find a problem, repair as necessary.

Assembly can begin by inserting the resistors. Use the resistor colour code table as an aid to reading the resistor values. A digital multimeter can also be used to measure each value. The two diodes (D1 and ZD1) can now be installed and these must be mounted with the orientation as shown. Install the five PC stakes.

Two 2-way headers are used, one for LK1 and the other as terminals to connect the microphone. Unless you want a normal sounding voice from the Interplanetary Voice, the LK1 jumper should be left off.

IC1 and IC2 can be mounted using sockets although this is not necessary and the ICs can be directly soldered to the PC board. When installing the sockets (if used) and the ICs, take care to orient these correctly. Orientation is with the orientation notch or dot adjacent to pin 1 positioned as shown toward the switches.

Capacitors can be mounted now. The electrolytic types must be oriented with the shown polarity. Keep the height of the electrolytic capacitors below 14mm overall above the PCB to provide clearance for the battery holder that mounts onto 15mm spacers over the PCB.

Cut the potentiometer shaft to 12mm long and remove the locating spigot at the side of body adjacent to the mounting thread. This is easily snapped off with pliers. Install VR1 and the switches S1-S4. VR1 should be connected (soldered) to the GND PC stake using a short length of tinned copper wire. An offcut from a resistor lead will be suitable. It is usually necessary to scrape away some of the coating on the pot body before soldering to the back of the pot, otherwise the solder

Parts List – Interplanetary Voice

1 PCB, coded, 08102121, 92 x 54mm (available from Silicon Chip for $15 +p&p)
1 panel label 58mm in diameter
1 flared speaker box port 58mm diameter x 120mm long
1 57mm diameter 8Ω loudspeaker
1 electret microphone insert 9.5mm diameter
1 62mm diameter x 1mm aluminium or fibreglass disc for speaker grille
1 58mm diameter x 1mm aluminium or fibreglass disc for front panel
1 rubber grommet with 9.5mm ID hole
1 9V PCB mount battery holder
1 9V Alkaline battery
1 50k 16mm log pot (VR1)
1 potentiometer knob
1 SPDT PCB mount toggle switch (S1) (Altronics S1421 or equivalent)
3 right angle tactile pushbutton PCB switches with 3.5mm actuator (S2-S4) (Jaycar SP-0606 or equivalent)
1 DIL8 IC socket (optional)
1 DIL18 IC socket (optional)
2 3mm LED bezels
3 15mm M3 tapped spacers
2 12mm M3 tapped spacers (or 1 25mm M3 tapped spacer cut to 2 x 12mm)
1 25mm M3 tapped spacer
1 M3 x 32mm screw
1 M3 x 10mm pan head or countersunk screw
3 M3 x 6mm screws
3 M3 x 6mm countersunk screws
2 2-way pin headers (2.54mm spacing)
1 jumper shunt
2 100mm cable ties
1 20-30mm diameter piece of thin rubber foam (eg, opened out earphone pads)
5 PC stakes
1 100mm length of single core screened cable
1 50mm length of light duty figure-8 wire
1 50mm length of red hookup wire
1 50mm length of black hookup wire

Semiconductors

1 HT8950 (18-DIP version) Voice Modulator (IC1) (*Do not use the HT8950A since this has 16 pins and different pinouts to the HT8950*)
(Available from www.littlebirdelectronics.com)
1 LM386N Audio amplifier (IC2)
1 3.6V 400mW zener diode (ZD1)
1 1N5819 1A Schottky diode (D1)
1 3mm red LED (LED1)
1 3mm green LED (LED2)

Capacitors

2 470µF 16V PC electrolytic
2 100µF 16V PC electrolytic
3 10µF 16V PC electrolytic
3 100nF MKT polyester
1 47nF MKT polyester
1 33nF MKT polyester
1 3.9nF MKT polyester

Resistors

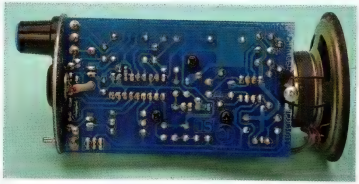
2 100kΩ	1 47kΩ	1 39kΩ	2 4.7kΩ	2 3.3kΩ
1 1.8kΩ	1 510Ω	1 470Ω	1 150Ω	2 10Ω

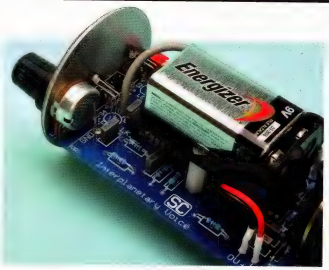
Miscellaneous

Silicone sealant, solder, heatshrink tubing

Handle

1 90 x 110 x 19mm solid timber (shaped for a handle)
2 cheese head wood screws 12mm long





(Above): a view of the back of the PCB, showing how it and the other hardware is assembled before insertion in the "case". At right is a close-up of the front end of the PCB with the various "front panel" controls.

will not adhere.

LED1 and LED2 mount horizontally but at a height of 13mm above the PCB. But firstly, bend the leads at 10mm back from the base of each LEDs at right angles making sure the anode lead is oriented toward S1 as shown on the overlay diagram.

The panel label for this project can be downloaded from the SILICON CHIP website (siliconchip.com.au). This file also contains a drilling guide for both the control panel and the loudspeaker grille. Go to the download section and select the month and year of publication. When downloaded, you can print the drilling guide onto paper.

Drill the panels as shown on the drill guide. Also remove the swarf from the edges of the holes with a larger drill or countersinking drill.

The front panel label can be printed onto sticky backed photo paper or onto plastic film. When using clear plastic film (overhead projector film) you can print the label as a mirror image so that the ink is behind the film when placed onto the panel. Once the ink is dry, cut the label to size. The paper or plastic film is affixed to the panel using an even smear of neutral-cure silicone. Holes in the label can be cut with a sharp hobby knife or a leather punch.

Installation

Fig.4 shows the assembly details for the Interplanetary Voice.

The electret microphone is mounted inside a rubber grommet attached to the front panel below the PCB. A length of shielded cable is used to connect the microphone to the PCB. The wire passes through a hole near LED2 on the PCB. Make sure the earth side of the electret connects to the shield. The shield at other end of the shielded cable connects to the earth pin on the PCB as shown for the electret wiring.

The 9V battery holder is secured to the PCB using 15mm tapped standoffs. The three mounting holes in the battery holder are drilled out to 3mm to accommodate the M3 screws. In doing this the original underside bushes at these battery-holder mounting points are also removed and cleaned up with a larger drill. This will allow the battery holder to sit closer to the PCB.

Bend the connecting pins on the holder backwards under the battery holder and solder leads to connect to the supply PC stakes on the PCB. M3 machine screws secure the standoffs to the PCB, while M3 countersunk screws are used for the battery holder.

The rear mounting point on the PCB utilises two 12mm and one 25mm long standoff. Cutting a 25mm standoff in half can make up the 12mm standoffs required (or use separate 12mm standoffs). These are secured to the PCB with an M3 x 32mm screw. The screw is first screwed into a 12mm standoff and the remaining screw thread section is inserted into the PCB from the underside and then screwed into the second 12mm standoff. The 25mm standoff then is screwed onto the last remainder of screw thread. The 25mm standoff is secured to the speaker port with an M3 x 10mm screw.

The front panel attaches to the PCB with the potentiometer nut. The LEDs are secured with 3mm LED bezels while switches S1-S4 simply protrude through the panel holes.

The speaker is glued to the grille disc. We used silicone sealant although many alternative types of glue can be used instead. When the glue or sealant is dry, solder the figure-8 wire to the speaker terminals and PC stakes on the PCB. The speaker is supported

Resistor Colour Codes

No.	Value	4-Band Code (1%)	5-Band Code (1%)
❑ 2	100kΩ	brown black yellow brown	brown black black orange brown
❑ 1	47kΩ	yellow violet orange brown	yellow violet black red brown
❑ 1	39kΩ	orange white orange brown	orange white black red brown
❑ 2	4.7kΩ	yellow violet red brown	yellow violet black brown brown
❑ 2	3.3kΩ	orange orange red brown	orange orange black brown brown
❑ 1	1.8kΩ	brown grey red brown	brown grey black brown brown
❑ 1	510Ω	green brown brown brown	green brown black black brown
❑ 1	470Ω	yellow violet brown brown	yellow violet black black brown
❑ 1	150Ω	brown green brown brown	brown green black black brown
❑ 2	10Ω	brown black black brown	brown black black gold brown

using cable ties that wrap through the speaker frame and around the standoffs. A 30mm diameter piece of thin rubber foam is affixed to the back of the speaker magnet to help keep the speaker in place.

The speaker should be positioned so that it is centred within the speaker port flare. This is when assembled into the speaker port with the 25mm standoff located up against the top inside of the speaker port.

A 3mm hole is required in the top of the speaker port flare for the M3 countersunk screw to secure the 25mm standoff. This is located 93mm from the non-flared port end as shown in Fig.4.

Note that a series of holes should be drilled into the speaker port to prevent the port acting as a tuned pipe. Without the holes, there will be sufficient resonance for feedback from the speaker to the microphon, causing a howling noise. This would occur with only moderate volume settings with at least two of the effects selections on the Interplanetary Voice. To allow a reasonable volume without feedback, we drilled a series of holes in the port. The holes are arranged as a row of eight 5mm diameter holes distributed along the length of the port and repeated at 45-degree intervals around the diameter. That's 64 holes in total.

A handle was fashioned from an off cut piece of timber and secured to the underside of the speaker port with two wood screws. The screw heads are set raised above the timber by the 2mm of the speaker port thickness. The shape of the handle is not critical so long as it is comfortable to hold. The handle can be finished with black paint or stain.

Two holes are drilled in the underside of the speaker port, large enough to allow the head of each screw to insert. Then slots are filed from each hole toward the flared end just wide enough for the screw but not for the screw head. Inserting the two screw heads into the holes and pushing forward so that the screws engage the slots attaches the handle. Removal is the reverse procedure pulling back the handle so the screw heads can be removed from the holes. The handle will need to be removed both to insert and to remove the Interplanetary Voice assembly within the speaker port.

Testing

Insert the 9V battery and switch on the Interplanetary Voice with the power switch. Power LED (LED1) should light. If not check the polarity of the LED. Measure the voltage using a multimeter between the GND PC stake behind VR1 and the cathode of ZD1. This should be a voltage that is around 3.6V although anywhere between 3.3 and 3.9V is OK. Speaking into the microphone should produce sound from the loudspeaker with suitable level set by the volume control. LED2 should vary in brightness with voice volume.

When power is first applied to the Interplanetary Voice, the voice effect is set for Robot. Pressing the Effect switch will change the sound from Robot and you can cycle through seven different effects with each switch press. Robot voice is selected at any time again with the Robot switch.

Pressing the Vibrato switch will add vibrato to the sound and pressing the Vibrato switch again will deselect vibrato. Adjust the volume control for the best effect from the Interplanetary Voice.

Note that excessive volume may ultimately produce feedback between the speaker and microphone, particularly with the Robot voice selection. Generally the volume is best adjusted to prevent feedback but for added

Fig.5: here's the "front panel" label which also serves as a drilling template. This and other diagrams can be downloaded from siliconchip.com.au

effects, set the volume just at the threshold of continuous feedback. This tends to make the voice ring for a short period.

Quiescent current consumption for Interplanetary Voice is about 40mA. More current is drawn from the battery as the Interplanetary Voice delivers sound. So we recommended you switch off power after use because the 9V battery won't last long otherwise.

Note that if you are not imitating a metallic voice sound, then LK1 can be shorted with a jumper shunt for a normal voice sound from Interplanetary Voice. That will allow you to speak to humans using their own style of voice. Alternatively, for normal voice, the Interplanetary Voice can be dispensed with altogether and using your vocal cords totally unaided.

But doing this you run the risk of being discovered as human rather than alien. SC

Here's the handle we made – it mates with the two "keyholes" in the Interplanetary Voice case. Note also the drilling required in the case.

Capacitor Codes

Value	µF Value	IEC Code	EIA Code
100nF	0.1µF	100n	104
47nF	0.047µF	47n	473
33nF	0.033µF	33n	333
3.9nF	0.0039µF	3n9	392

Ultra-LD Mk.3 13 stereo amplifier

Chassis assembly and wiring details

AT THE HEART of this new stereo amplifier are two Ultra-LD Mk.3 power amplifier modules, as described in the July and August 2011 issues of SILICON CHIP. The Mk.3 is by far the best class-AB amplifier module ever published and features astonishingly low total harmonic distortion and noise (THD + N) figures and a power output of 135W RMS into 8Ω. Alternatively, it can deliver around 200W RMS into 4Ω.

We followed that with a suitable power supply module in September 2011, then described a loudspeaker protector and muting module in October 2011. The latter is basically a slightly modified version of the very successful design used in our Class-A Stereo Amplifier described from June 2007 to September 2007.

The preamplifier and input selector modules followed in November and December 2011. As with the loudspeaker protector, the preamplifier is a tweaked and enhanced version of the high-performance unit originally designed for the Class-A Stereo Amplifier.

This month and next month we will show you how to assemble everything into a custom steel case that's been designed in conjunction with Altronics. This precision laser-cut chassis is supplied with all holes drilled and with pre-punched front and rear panels with screened lettering. Also next month we will present the performance measurements of the complete amplifier.

Optimised layout

The final layout of the modules inside the case and the wiring between them has been carefully optimised to give the best overall performance from the individual modules. It is not simply a matter of plonking the modules inside the case and wiring them in a haphazard way. The details of the wiring must be closely followed.

The result is a powerhouse stereo amplifier with state-of-the-art performance. In fact, we feel very confident in stating that there are very few commercially available amplifiers that would go close to it in performance,

Where To Buy Kits

A kit of parts for the Ultra-LD Mk.3 Stereo Amplifier is available from Altronics, 174 Roe St, Perth, WA 6000, Australia. The kit is complete and includes the seven modules (unassembled) and a pre-punched steel chassis similar to that shown in the photographs.

Alternatively, you can purchase the individual kit modules and the chassis separately – see the Altronics website at **www.altronics.com.au** for further details.

Note that the kit does not include an infrared remote control handpiece. The unit will work with most universal remotes including the Altronics A1012.

Pt.1: By GREG SWAIN

Based on the series of high-performance modules described last year, this superb stereo amplifier can deliver 135W RMS per channel into 8Ω and boasts extremely low noise and distortion figures. It includes infrared remote control of volume and input selection and is straightforward to assemble.

regardless of price. In fact, money cannot buy the fully assembled version of this Ultra-LD Mk.3 Stereo Amplifier – you have buy the kit or all the modules and assemble it yourself.

At the end of that process, you will have a stereo amplifier with unmatched performance.

Having said that, note that it will take a lot of time to fully assemble and test each module and then put it all into the case. We estimate that it might take up to 40-50 hours to do the whole job. It's all pretty straightforward to do. Don't rush the job and you will end up with a professional result.

As shown in the photos, the case is finished in a tough black powder coating and the front panel features bevelled top and bottom edges to give it a professional appearance. At 420 x 425 x 88mm (W x D x H), it's really quite a large unit but that's necessary to accommodate the large finned heatsinks used for the Ultra-LD Mk.3 amplifier modules and to allow the various modules and the large toroidal mains transformer to be logically placed inside the chassis.

The large chassis also aids ventilation and cooling. The bottom of the chassis and the lid also have large ventilation slots which line up with the gaps between the heatsink fins, to allow the air to circulate between them.

The modules

To summarise, these are the modules that you need to build this amplifier:

- 2 x Ultra-LD Mk.3 power amplifier modules (July-August 2011);
- 1 x power supply module (September 2011);
- 1 x loudspeaker protector module (October 2011);
- 1 x stereo preamplifier module (November-December 2011); and
- 1 x 3-way stereo input selector module plus its companion switch board (November-December 2011).

Each of these modules will be available separately in kit form from Altronics and the chassis will also be available separately. In addition, Altronics will be selling a complete kit of parts for the new amplifier. This will include all the above kit modules,

INPUT SELECTOR BOARD
10-WAY RIBBON CABLE UNDER 14-WAY CABLE
SELF-ADHESIVE FLAT CABLE CLAMP
FIT ADDITIONAL SELF-ADHESIVE FLAT CABLE CLAMPS TO SPEAKER CABLES – SEE PHOTO
RIGHT SPEAKER TERMINALS
LEFT SPEAKER TERMINALS
LOUDSPEAKER PROTECTOR BOARD
MK3 POWER SUPPLY BOARD
SECONDARY EARTH POINT 1
MAIN CHASSIS EARTH
240V PRIMARY LEADS
GREEN/YELLOW (EARTH)
MALE IEC CONNECTOR WITH INTEGRAL FUSE
T1
BR1
CON1
CON2
CON3
40V
0V
40V
18V
0V
18V

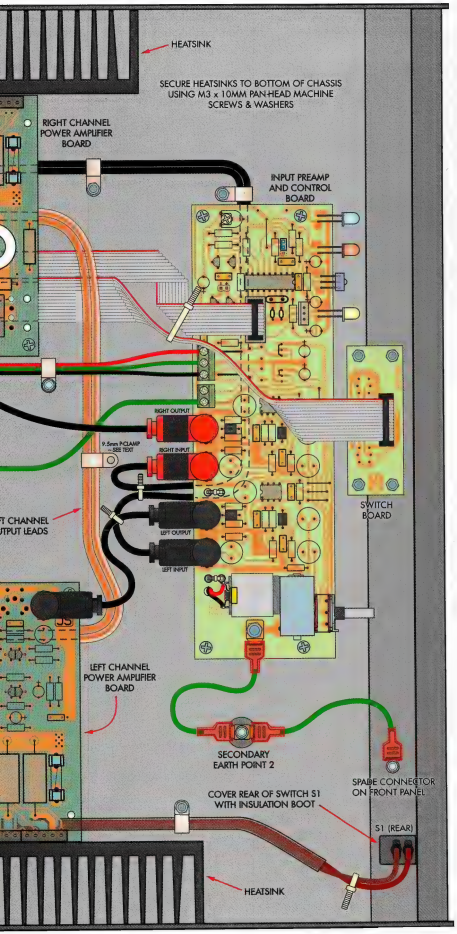


Fig.1: follow this wiring diagram to assemble the amplifier and complete wiring. Route the various leads as shown to ensure optimum performance and take particular care with the mains wiring.

the transformer and the chassis, plus other sundry parts

OK, let's assume that you've completed all the modules as previously described and that you're ready to mount them in the chassis and install the wiring. We'll get to that shortly but first, you have to do some work on the case itself.

Preparing the case

As mentioned, the case is finished in a tough powder-coating. That also acts as a good insulator so you must take steps to ensure that all sections of the case, including the side panels, the front and rear panels and the lid, are correctly earthed. That means ensuring they make good electrical contact with each other.

There are two reasons for this: (1) all sections of the case must be connected to the mains earth to ensure safety; and (2) correct earthing is necessary to keep RF interference out of the audio circuitry.

The first step is to ensure that the two side panels and the lid are earthed to the bottom section of the chassis. That's done by using an oversize drill to remove the powder coating from the countersunk screw holes. Use drills that are slightly smaller in diameter than the screw heads and be sure to remove the powder coating right back to the bare metal.

Don't just do this for one or two holes – do it for all the holes in each panel. Provided you use a drill that's not too big, the bare metal will later be covered by the screw heads.

Next, scrape away the powder coating around the screw holes inside the side panels and from around the three holes on the underside of the lid at the rear. That done, scrape away the powder coating from the matching contact areas around the screw holes in the chassis and at the top of the rear panel. When the case is subsequently re-assembled, earthing takes place via the screws themselves and also via direct metal-to-metal contact between the various sections.

The front and rear panels are earthed by running leads from quick connect

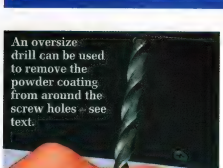
You Must Use A Ratchet-Driven Crimping Tool

One essential item that's required to build this amplifier is a ratchet-driven crimping tool, necessary for crimping the fully-insulated quick-connect terminals to the leads.

Suitable crimping tools include the Altronics Cat. T-1552, and the Jaycar TH-1829. These all feature double-jaws so that the bared wire end and the lead insulation are crimped in a single action.

Don't even think of using one of the cheap (non-ratchet) crimpers that are typically supplied in automotive crimp kits. They are not up to the job for a project like this, as the amount of pressure that's applied to the crimp connectors will vary all over the place. This will result in unreliable and unsafe connections, especially at the mains switch and IEC socket terminals.

By contrast, a ratchet-driven crimping tool applies a preset amount of pressure to ensure consistent, reliable connections.



An oversize drill can be used to remove the powder coating from around the screw holes – see text.

terminals back to separate earth terminals bolted to the bottom of the chassis (see wiring diagram). In the case of the rear panel, the quick connect terminal is bolted into position using an M4 x 10mm screw, two starwashers and two nuts. Be sure to scrape away the powder coating around the mounting hole on the inside of the panel before bolting the quick connector into position as shown in Fig.3 – ie, the quick connector must contact bare metal.

By contrast, the front panel quick connect lug is welded into position, not far from the power switch position. It's accessed through a cut-out in the front sub-panel (not shown on the prototype).

It's also a good idea to remove the powder coating under the screws that are used to secure the front and rear panels in place. That way, these panels will be earthed to the chassis via both the mounting screws and the quick connector leads to the earth points when they are later installed.

Transformer mounting bolt

The transformer mounting bolt must also be earthed and this means that you have to remove the powder coating from around the mounting hole on the bottom of the chassis (ie, from under the bolt head). The same goes for all other mounting screws that go through the bottom of the chassis. In particular, make sure that you clear away the powder coating from around the six heatsink mounting holes and from around any screw holes adjacent to the IEC socket and the mains switch.

Once you've done all this, remove the front panel, wrap it up and put it to one side, so that it doesn't get scratched or damaged while you are installing the parts in the chassis and completing the wiring.

Installing hardware

You can now install some of the hardware. Fig.1 shows the general layout inside the case.

Begin by securing the IEC power socket to the rear panel using the two 6g x 12mm countersink self-tappers supplied. **Once it's in place, smear some neutral-cure silicone sealant over the metal strip that runs down one side of the IEC socket between the Active input and one end of the fuse (see photo).** This is a worthwhile precaution since that strip has 230V AC on it when power is applied.

That done, secure the loudspeaker terminals (with their leads attached) in position, again using 6g x 12mm countersunk self-tappers.

The 35A bridge rectifier (BR1) can now go in. It uses the chassis for heatsinking, so it's important to ensure good metal-to-metal contact.

This metal strip on the IEC socket operates at 230VAC and should be insulated using silicone sealant.

Its chassis-mounting area must be completely free of powder coating; if not, mark out the area and remove the powder coating using a small grinding tool and a sharp scalpel.

The powder coating should also be removed from around the mounting hole on the bottom of the chassis, so that the head of the mounting screw will also make good contact.

Once that's done, smear the underside of the bridge rectifier with heatsink compound and bolt it to the chassis using an M4 x 20mm machine screw, star washer and nut. Fig.1 shows BR1's mounting location and orientation.

Chassis earth connections

As shown in Fig.1, there are three earth points on the bottom of the chassis – two at the rear (to the right of the power transformer) and one at the front, near the mains switch.

The rearmost earth point is used exclusively for the mains earth (more on

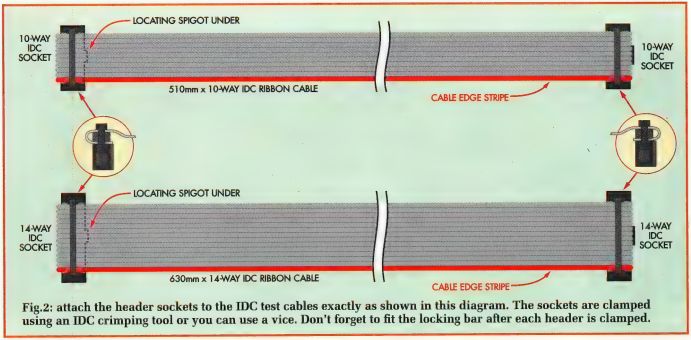


Fig.2: attach the header sockets to the IDC test cables exactly as shown in this diagram. The sockets are clamped using an IDC crimping tool or you can use a vice. Don't forget to fit the locking bar after each header is clamped.

this next month). The adjacent chassis point (to the right) is used to earth the power supply module and the rear panel. This latter point is fitted with a double-ended quick connect terminal as shown in Fig.3. Secure it using an M4 x 10mm machine screw, two star washers and two nuts. The top nut locks the bottom one in position so that there's no possibility of the assembly coming loose.

The front chassis earth point is also fitted with a double-ended quick connector and is secured in exactly the same manner. This point is used to earth the front panel and the metalwork of the pot.

As supplied, the chassis should be clear of powder coating around the earth mounting holes, to ensure good metal-to-metal contact. If not, be sure to scrape away the powder coating as necessary.

Making the IDC cables

Before mounting the various modules in the chassis, you need to make up a number of simple cable assemblies. So that's what we'll do now.

The first step is to fit the headers to the two IDC (flat ribbon) cables. Fig.2 shows how these are made. Note that pin 1 on the header sockets is indicated by a small triangle in the plastic moulding and the red stripe on each cable must always go to this pin.

Start with the 10-way IDC cable. It should be cut to a length of 510mm and then attached to the IDC headers using either a vice or an IDC crimping tool (eg, Altronics T1540 or Jaycar TH-1941). The cable is then folded back across the headers at each end and the locking bars installed.

Take care when fitting the cable to the headers. In particular, note that after each crimping operation the cable is folded back through 180° before the locking bar is fitted. Study Fig.2 carefully; it's all too easy to feed the cable to the header from the wrong direction.

The 14-way (630mm-long) IDC cable is made up in similar fashion.

Shielded audio cables

The twin audio cable that runs from the input selector board to the preamp can now be made. As shown in Fig.1, this is fitted with right-angle RCA plugs at either end – red for the right channel and black for the left.

To fit these plugs, first pull off the plastic cable entry collars, then split the casings to gain access to the solder terminals. That done, cut the twin shielded audio cable to 600mm and separate the individual leads at either end over a distance of about 40mm. The cable ends can then be stripped and terminated to the plugs – red wire to the red plugs, white wires to the black plugs.

Make sure that each shield wire goes to the "earthy" side of its RCA plug (ie, to the terminal that's connected to the outer collar).

Next, cut four 10mm lengths of 20mm-diameter heatshrink tubing and slip one over each plug and down the leads. The plastic casings can then be refitted to the plugs, after which the heatshrink pieces are slid over these casings and shrunk down to secure them in place.

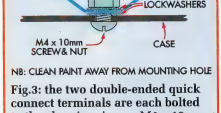


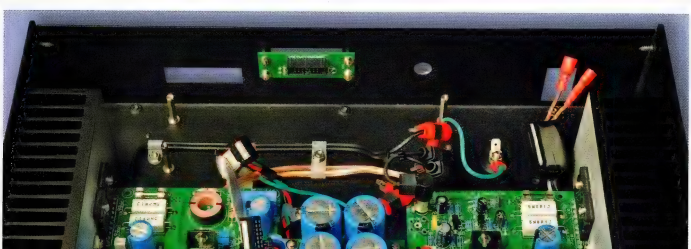
Fig.3: the two double-ended quick connect terminals are each bolted to the chassis using an M4 x 10mm screw, star lockwasher and two M4 nuts. The same arrangement is used to secure the single-ended quick connect terminal to the rear panel.

The original cable entry collars are discarded.

By the way, be sure to use figure-8 (stereo) audio cable for this lead – ie, with the inner conductors individually shielded. Don't use 2-core cable with a single shield. And if you're wondering how to strip the very fine inner conductor, the answer is to use an adjustable wire stripper such as the Altronics T1510.

Once the RCA plugs have been attached, fit cable ties to the figure-8 cable at both ends, to prevent the leads from separating any further.

The left-over figure-8 audio cable can now be used to make the two audio leads that run from the preamplifier to the power amplifier. Separate the



This photo shows how the input audio cable is secured to the floor of the chassis using 5mm-diameter P-clips, so that it runs under the rear edge of the preamplifier module. A 9.5mm-diameter P-clip also secures the speaker cable from the left-channel power amplifier and this is fastened using a shared mounting screw with one of the 5mm-diameter P-clips.

cable and cut off 85mm and 185mm lengths for the left and right channels respectively. Fit black right-angle RCA plugs to the 85mm cable and red RCA plugs to the 185mm cable and secure the plastic casings with heatshrink as before.

Speaker cables

The two speaker cables are made by cutting 490mm and 300mm lengths of heavy-duty (either 41/0.20mm or 102/0.12mm) figure-8 cable. That done, remove about 4mm of insulation from the wires at each end and pre-tin them so that they can later be soldered to the amplifier and loudspeaker protector modules.

Once these cables have been prepared, cut two 80mm lengths from the leftover cable and solder them to the loudspeaker terminal panels.

Power amplifier supply cables

You can now make the two short power supply cables for the Ultra-LD Mk.3 amplifier modules. These each consist of three 80mm heavy-duty (32/0.20mm) leads (red, black and blue) which are connected to Molex Mini-fit Jr 3-pin female line plugs.

Crimp and lightly solder the leads to the pins before inserting them into their matching locations in the plastic plug shells (see Fig.1). Be sure to use a red lead for the +57V connection, black for 0V and blue for -57V.

Once the Molex plugs have been fitted, strip about 5mm from the free ends of the leads and secure them to the screw terminal blocks on the power supply module. Be careful not to get these connections mixed up – you could fry the transistors on the power amplifiers if you do.

In addition, you have to solder a 110mm green earth lead to the front of the power supply module (this lead later connects to the 0V rail on the preamp PCB). Note that this 0V (earth) connection point was absent from early versions of the power supply PCB but should be included on PCBs sold with the kit.

If you do have an early version of the power supply PCB, simply drill a 1.5mm hole in the location shown but be careful not to damage the adjacent electrolytic capacitors. It's then just a matter of scraping away the masking from around this hole to expose the bare copper before soldering the lead.

Earth leads

The next step is to make up the front and rear panel earth leads. These are made using 75mm and 70mm lengths respectively of green 32/0.20mm wire and are fitted with fully insulated spade connectors at each end (strip about 5mm of insulation from the wire ends before fitting the connectors). A 75mm-long lead is also used to earth the volume control metalwork and this should also now be made.

You can also make the earth lead that connects the TERM2 (or CT) terminal on the power supply module to chassis. This earth lead is 160mm long and is again fitted with fully insulated spade connectors at each end.

Finally, you can make the mains earth lead (ie, the one from the IEC connector to chassis). This lead is 175mm long and is terminated in a crimped 4mm eyelet connector at one end and a fully-insulated spade connector at the other.

Installing the modules

Now comes the fun part – installing the modules, hardware and cables into the chassis. Note that all modules except for the preamplifier are mounted on 10mm tapped spacers and generally secured using M3 x 6mm machine screws and flat washers. The preamplifier is mounted on 25mm tapped spacers.

Start with the input selector module. This is fitted by first securing its stereo RCA sockets to the rear panel using three M2 x 12mm machine screws and nuts, or you can use No.3 x 10mm self-tappers if supplied. It's then attached at the front on two 10mm spacers (the other two mounting holes are not used).

Once this module is in position, plug the stereo audio cable into the selector module's output sockets, then secure the cable to the floor of the chassis using five 5mm-diameter Nylon P-clamps (see Fig.1). These clamps are secured using M4 x 10mm machine screws, flat washers and nuts.

This next bit is important – you must fit two M4 washers under the head of the screw that secures the P-clamp under the amplifier module

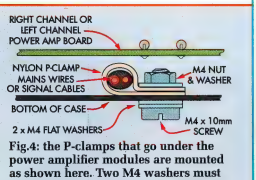


Fig.4: the P-clamps that go under the power amplifier modules are mounted as shown here. Two M4 washers must be fitted under each screw head, so that the screw cannot short against the PCB.

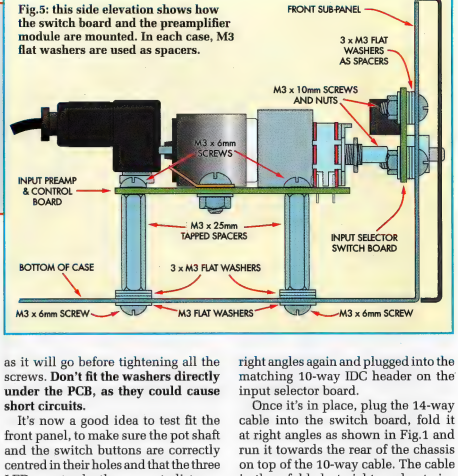


Fig.5: this side elevation shows how the switch board and the preamplifier module are mounted. In each case, M3 flat washers are used as spacers.

– **see Fig.4.** This is necessary to provide sufficient clearance between the end of the screw and the underside of the amplifier module when it is later installed.

Note that one of the P-clips sits under the preamplifier and is not shown in Fig.1. However, its location is clearly shown in one of the accompanying photos. Note that the screw that secures this 5mm P-clip is also used to secure a 9.5mm-diameter P-clip for the left channel loudspeaker cable when that's later installed.

Having secured the audio cable, install the switch board in the chassis. Fig.5 shows the mounting details – it's secured to the front sub-panel using four M3 x 10mm machine screws, nuts and washers, with three additional washers used as spacers at each corner. Centre the board vertically in its slotted mounting holes before tightening the screws.

The preamplifier can now be installed but first you have to fit a 2-way screw terminal block to its CON5 position (ie, adjacent to the 3-way screw terminal block). This terminal was originally left off the board but is now necessary so that the preamp supply earth can be connected to the power supply earth.

As previously stated, the preamp is mounted on M3 x 25mm spacers. In addition, three M3 flat washers must be fitted between each spacer and the chassis – see Fig.5. This raises the preamp slightly, so that the centre of the pot shaft is centred in its hole when the front panel is later fitted.

In practice, it's easier to loosely fit the spacers and washers to the chassis first, then drop the preamp module into place and install its mounting screws. You then push the assembly back in its slotted chassis holes as far as it will go before tightening all the screws. **Don't fit the washers directly under the PCB, as they could cause short circuits.**

It's now a good idea to test fit the front panel, to make sure the pot shaft and the switch buttons are correctly centred in their holes and that the three LEDs protrude the correct distance through the panel. The switch buttons should either sit flush with the panel or just protrude slightly.

Note that the top of the front panel is pulled back slightly when the lid is fitted, so be sure to make allowance for this.

If the switch buttons are off-centre, it's simply a matter of raising or lowering the switch board until they are correct. You can also add or remove spacer washers if necessary so that the switches sit flush with the front panel. The preamp height can be similarly adjusted, if the pot shaft isn't centred vertically in its front-panel hole.

Once everything is correct, remove the front panel again and put it away where it won't get damaged.

Flat ribbon cables

The next step is to fit the 10-way and 14-way flat ribbon (IDC) cables. The 10-way cable goes in first. Plug it into the IDC header on the preamplifier, then drop it down and run it straight back along the floor of the chassis as shown in Fig.1. The cable is then folded at right angles and routed towards the side panel, then folded at right angles again and plugged into the matching 10-way IDC header on the input selector board.

Once it's in place, plug the 14-way cable into the switch board, fold it at right angles as shown in Fig.1 and run it towards the rear of the chassis on top of the 10-way cable. The cable is then folded at right angles twice more and plugged into the 14-way IDC on the selector board, adjacent to the rear panel.

Finally, push the IDC cables into two self-adhesive flat cable clamps and anchor them to the floor of the chassis in the positions shown.

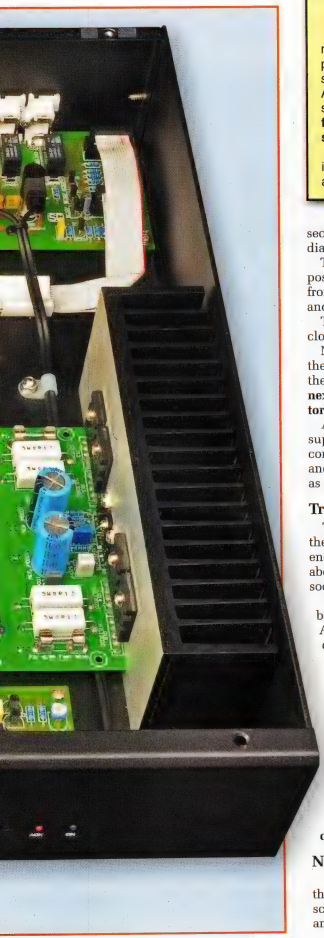
Adding more modules

The power supply is the next module to install. That done, you can connect the earth lead from the power supply module to the negative (-) terminal of CON5 on the preamplifier module and install the +15V, 0V, -15V wiring. This consists of three heavy-duty (32/0.20mm) leads (red, green and black) which are twisted together, cut to length and terminated at either end in screw terminal blocks.

Twisting these leads together keeps them nice and neat. The best way to do this is to first clamp them at one end in a vice. The free ends are then secured in a hand-drill chuck and the handle rotated until you get a nice even lead twist along the full length of the cable.

That done, the wires can be trimmed, stripped and secured at each end using heatshrink or cable ties. They are then

This is the view inside the completed Ultra-LD Mk.3 Stereo Amplifier. Note that the mains transformer used here was fitted with an external copper strap held in place by a ring clamp. By contrast, the transformer supplied with kits will come with an integral flux band, so constructors will not have to add this (see panel next month).



WARNING! HIGH VOLTAGE

High AC and DC voltages are present in this circuit. In particular, mains voltages (230V AC) are present on the IEC socket and the primary side of the transformer (including the wiring to the power switch). In addition, the transformer secondary provides an 80V AC output (2 x 40V AC centre-tapped) and the amplifier power supply rails total 114V DC. **Do not touch any part of the amplifier circuitry when power is applied otherwise you could get a severe electric shock.**

The two LEDs on the power supply board indicate when power is present. If they are alight, the power supply and amplifier boards are potentially dangerous.

secured to the floor of the chassis at the preamp end using a 5mm-diameter P-clamp.

That done, the loudspeaker protection module can be mounted in position and the 20V DC supply wiring and 30V "AC sense" wiring run from the power supply board. Use two self-adhesive cable-tie mounts and cable ties to secure the DC supply wiring as shown.

The twisted "AC sense" can be cable-tied to the DC supply wiring, close to the loudspeaker protector module.

Note that you will have to temporarily disconnect this wiring from the loudspeaker module later on, so that it can be lifted up to make the solder connections for the loudpeaker cable wiring. **As explained next month, these connections must all be soldered, as quick connectors can cause distortion.**

At this stage, you can also install the wiring between the power supply board and the DC terminals on the bridge rectifier. This wiring consists of red and black heavy-duty leads which are twisted together and terminated at both ends in spade connectors. Connect these leads as shown in Fig.1, then secure both ends with cable ties.

Transformer mounting

The next step is to install the large toroidal transformer. As supplied, the toroidal transformer has a 620mm brown primary lead that's long enough to reach the mains switch. The other primary lead (blue) is about 240mm long and this goes to the Neutral terminal of the IEC socket (more on this next month).

Before fitting the transformer, check that the powder coating has been scraped away around its mounting hole underneath the chassis. As stated earlier, this is necessary to ensure that the head of the bolt contacts bare metal, so that the bolt is correctly earthed.

Having done that, bolt the transformer in place. It's supplied with two neoprene rubber washers and these must go between the toroid itself and the two dished metal cup plates. In other words, one metal plate sits against the chassis. A rubber washer then sits on top of this, then the toroid is placed in position.

The second rubber washer is then fitted and finally the second metal plate sits on top of this and the whole assembly secured using the large mounting bolt.

Do the nut up finger-tight to begin with, then rotate the transformer so that the blue and brown primary leads point directly towards the left-channel speaker terminals. **That done, do the nut up firmly but don't over-tighten it otherwise you'll distort the metal chassis (and possibly even damage the transformer).**

Next month

That's all we have space for this month. Next month, we'll complete the construction of the new Ultra-LD Mk.3 Stereo Amplifier and describe the test and set-up procedure. We'll also publish the parts list and give the specifications. SC

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SERVICEMAN'S LOG

Lots of reasons for internet problems

Dave Thompson*

There are lots of factors that can cause slow internet speeds or connection problems – apart from a run-down telephone system, that is. Sometimes, the answer can be as simple as changing the brand or model of the modem, even if the technicalities for doing so aren't exactly clear.

There's no doubt that the internet is an amazing resource. However, ask many users, especially here in New Zealand, and they'll tell you that their internet connection is too slow.

In fact, one of the most common computer-related questions we hear at our workshop is whether we can "add more memory to the computer or do something to it to speed up the internet?". That's a tricky one because many people don't understand that their computer doesn't have much to do with how fast their internet connection is. Pedants will no doubt suggest that processing speed can have an effect on internet speed, however most modern machines run fast enough for this not to be a factor.

That said, perceived internet speed isn't solely about data transfer rate; many computer users lump in their web browser's opening and page-loading times as part of their overall internet experience and CPU speed and memory availability definitely have an effect there. Slow browser performance (and security) is why so-called "alternative" browsers are proving so popular these days. Many people consider Opera, Chrome and Firefox to be better than Microsoft's Internet Explorer, while others prefer Safari which comes with MacOS.

Users of alternative browsers often point out that while "their" browser renders pages faster than Internet Explorer, IE still seems to launch a lot faster. However, Internet Explorer only appears to open faster because most of it is already preloaded into memory on Windows start-up; in other words, it has a head start. However, like many other programs, once a competing browser is opened and loaded into memory, it also re-opens more quickly.

Getting back to our original theme, if computer speed has no real effect on line/data transfer speed, then what does? Unfortunately, there is no one-size-fits-all answer here; each case must be taken individually.

In days gone by

In days gone by, when dial-up internet was the norm, 95% of connection problems could be put down to telephone lines, whether on the pole outside or with extension cables and/or adapters within the home. Indeed, many older lines and their associated connections had trouble coping with voice traffic, let alone the new-fangled Internet data as well.

Because modems quickly proved themselves to be reliable, we usually tried to get clients to check a few things out themselves before we got involved and started charging. This involved asking if they were using any telephone extension cables and/or adapters and if so, changing or removing them and trying again. We also asked if they had other devices loading/affecting their lines (fax machines were known to upset certain modems).

Once we'd ruled out that it was anything local causing the problems, we'd then advise the client to call their ISP or telephone line provider to make sure there were no known issues affecting the internet and, if necessary, to get their line tested. After years of dealing with these companies, I've observed that their standard operating procedure is the reverse of ours, ie, assume initially that the line is fine and that any problems must therefore lie with the client's computer or modem.

A loss of faith

Unfortunately, my own experience with a flaky Internet connection caused me to lose faith in telephone companies and their line tests many years ago. It started when the tele-

Items Covered This Month

- Lots of reasons for internet problems
- Resurrecting a copier/printer
- A gremlin in the church laptop
- The pain of staying beautiful

**Dave Thompson, runs PC Anytime in Christchurch, NZ.*

Servicing Stories Wanted

Do you have any good servicing stories that you would like to share in The Serviceman column in Silicon Chip? If so, why not send those stories in to us? In doesn't matter what the story is about as long as it's in some way related to the electronics or electrical industries, to computers or even to car electronics.

We pay for all contributions published but please note that your material must be original. Send your contribution by email to:

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Resurrecting A Copier/Printer

T. F. of Chinderah, NSW managed to resurrect a a printer that really had nothing wrong with it, although the firmware insisted otherwise. Here's his story . . .

My hackles rise whenever I find manufacturers who seem to build "planned obsolescence" into their products. This was recently the case with my neighbour's copier/printer. It had been fitted with new ink cartridges several times and worked well until one day it refused to print and a bright orange LED flashed on the control panel.

The LCD screen simply read "Unable to Clean", which the user's guide said was caused either by a mechanical problem or a foreign obstacle such as a clip or ripped paper stuck in the machine. I opened the scanner cover but could not see any such foreign objects so I switched off the power and tried again but the symptoms remained the same.

Because the message on the LCD was vague, I sent an email to the manufacturer's support department asking for clarification. They replied that since the printer was out of warranty, I might find it more economical to purchase a new machine, as the parts and labour charges would probably cost more than a new machine. So not much help there!

I then Googled the "Unable to Clean" message on the Internet and found several forums where people had been asking for help with this message. And among these discussions, I found instructions detailing how to reset the "Purge Count" (whatever that was), which would clear the problem.

With nothing to lose and with the printer otherwise headed for the tip, I followed the instructions. These included pressing the Menu and Mono keys at the same time and then using the Up arrow key four times to enter the maintenance mode. Then 80 was entered using the Up arrow key and set. The Mono Start key was then used to cycle the items until "Purge Count" appeared on the display.

It didn't end there. Next, 2783 was entered using the Up arrow key and set which resulted in the "Purge Count" being reset to zero. Pressing the Stop key then returned the unit to the maintenance mode and pressing "9 Set" twice exited from this mode.

Talk about hidden secrets – it reminded me of my father's Freemason days and those special handshakes!

Having gone through this routine, I powered down the printer and restarted it. And that did the trick – the "Unable to Clean" message and the orange flashing LED had disappeared and the printer now worked perfectly. However, I initially placed it on newspaper in case the tank actually did overflow.

Actually, this was my second such experience of resurrecting a printer from the dead. Several years ago, my own Canon printer stopped working and started flashing out a code which was deciphered as "Ink Overflow Tank Full".

This seemed a simple enough task to tackle, so I pulled the printer apart. The ink overflow tank was easy to locate and it turned out to be only about 20% full. I soon washed out the block of absorbent paper and microwaved it nearly dry. That done, I reassembled the printer but it still flashed the "Ink Overflow Tank Full" message. There were no sensors in the tank, so it had no way of knowing that it was now empty.

As in the last story, the internet came to my rescue and I quickly found out how to reset the printer overflow tank counter. Apparently, the printer merely counts the number of pages that have been printed and after a certain number it stops working and displays the "Ink Overflow Tank Full" message. It's clearly conservative in its estimate, which is preferable to having the tank actually overflow, I guess.

Resetting the counter involved a complicated routine of holding down buttons while powering up the machine and then pressing combinations of buttons several times. When I did this, the "Ink Overflow" message disappeared and the printer gave several more years of satisfactory service.

phone started playing up. The symptoms were lots of static/noise on the line and the dial-up modem I was using at the time was constantly dropping the connection.

Those who remember having to queue to connect to one of the limited number of dial-up connections available at their ISP will know just how frustrating this can be, especially after 20 minutes of failed attempts. On that particular night, I just couldn't reconnect and in desperation called my ISP for help.

After the usual 45-minute wait, a bored help-desk pilot informed me there were no known issues and advised calling the telephone people, which I did. And so, after another 45-minute wait, I finally got through to another bored tech-support "professional" who curtly told me that it must be the cordless phone I was using.

After much arguing that it was not the cordless phone, he reluctantly said he would run a line test and call me back. He did and the result was that my lines were showing up as "excellent". I then asked him whether the noise he could hear on the line was acceptable. He agreed it wasn't and arranged for a technician to come and take a look "sometime within the next few days".

The next morning I couldn't even get a dial tone and so I used my mobile to call and ask for a technician to come out sooner. To their credit, he arrived within a couple of hours and after working his way through everything told me that the connections on the pole had completely corroded away and it was amazing it had worked at all. He also said that they had last been serviced at least 30 years previously.

Once they had been re-terminated, voice traffic was crystal clear and the modem connection rock solid. All of which is just a long-winded way of saying that I now put zero faith in line tests.

Creaky copper

Nowadays, the majority of Internet users connect via broadband over the same creaky, old copper wires and the line integrity now has an even greater effect on maintaining reliable

AFTER THE USUAL 45 MINUTE WAIT, A BORED HELP-DESK PILOT INFORMED ME...

connections. There are also other considerations; we recently had a situation where a client complained of slow internet speed and we tried all the usual remedies before finally swapping their router.

When we did so, their speed improved considerably and we discovered the reason while we were setting up their wireless connection. It turned out they'd set up a wide-open access point and two neighbourhood users were connecting and using our client's internet access and bandwidth. Setting a wireless network key soon closed the loophole and restored the usual connection speed.

Take nothing for granted

Nothing should be taken for granted when it come to diagnosing internet problems. One common problem, for example, is that many people don't install the correct line filters required for proper ADSL modem operation and then complain that the internet drops out frequently. Or they do install filters but forget about putting one on their monitored alarm system, the fax machine in the garage or their digital TV connection

Indeed, very few people make the connection between unfiltered phone lines and internet connection drop-outs. As a result, it's important for technicians to take nothing for granted and to not assume that the customer has done everything right when they get involved in these types of jobs.

Another factor is that certain brands and/or models of modem-routers just won't work properly in some client's homes, often for no obvious reason. We typically supply a certain make and model of router for ADSL connections and a matching model for those using the cable broadband system. These units are reasonably priced (not "cheap") and are usually very reliable.

However, every now and then, we'll find one that gives trouble. Initially, we replace it with an identical unit in case it was faulty. If it still doesn't behave, we then try a completely different make and model and that often resolves the issue.

The same thing can happen with the wireless (WiFi) side of things, where one make and/or model doesn't cut through two plasterboard walls whereas another brand and model works fine. It's just one of those anomalies that that you have to know about and be prepared for. I have seen ISP

A gremlin in the church laptop

A. F. of Chinderah, NSW recently found himself doing good work in church. But it didn't all go smoothly for him when he tried to operate the church laptop . . .

Recently, I agreed to drive a laptop computer for my local church. This is loaded with a PowerPoint program called "Easy Worship" and is used during the Sunday service to drive a projector to display the words of the songs and the announcements, etc.

Using the program is not very difficult but gremlins do creep in, often at the worst times. Unfortunately, during my first "solo" operation, the laptop froze and would not respond to the mouse, right in the middle of a hymn.

Now this has happened to me many times with computers (no, not in the middle of a hymn) and it is usually not a big deal – just hold the power button in for five seconds to shut down the machine, then wait 10 seconds and hit the power button again to reboot and restart the recalcitrant program. However, when you are in front of a congregation who are in full swing singing to the words on the screen, and the program freezes, the word "panic" takes on a whole new meaning.

Later, I discovered that because I had been nervous, the moisture on my fingertips made the touch pad super sensitive and the machine interpreted my sliding finger to be "double taps". These then activated any icon on the screen that the mouse passed over.

As a result, I had accidentally started several "PowerPoint" processes at once. Unfortunately, the laptop couldn't handle this and so it froze.

It's not only God who moves in mysterious ways!

support people send out router after identical router to clients without fixing a problem and when we come along, we simply install another make or model and the problem is solved.

Of course, ISPs often give away hardware as part of the deal so they aren't really in a position to send out a different brand of unit. Even so, they should at least be aware of this issue. There is often no obvious technical rhyme or reason for many connectivity problems and in the end, it's often just a matter of trying something different.

Perhaps the biggest issue affecting internet speed in NZ is the amount of people plugged into what, it has to be said, is a pretty creaky, old system. There has been much wringing of hands and gnashing of teeth about both the landline and broadband systems in New Zealand, almost all of which is political.

Unlike many other countries, we have relatively few people spread out over a huge area. Getting broadband into remote areas is a hot potato not may telephone companies want to handle and has resulted in some towns pooling their resources to buy satellite dishes and the necessary networking gear required to plug themselves into the WAN. However, we also have people less than 20km from major towns that cannot access landline-based broadband either and that is a disgrace in this day and age.

The kicker is that even though we pay an arm and a leg for what internet we do get, there are still not enough subscribers to pay for a decent system. So sometimes our internet speeds are slow because the system is slow and unless they give us a new one, that's not going to change.

Snail in a sticky bathtub

Couple this with too many people using the same creaky lines and nodes and the internet can sometimes be about as fast as a snail in a bathtub of glue. The cable broadband system used to be fantastic. It also used to be expensive and was only available in some areas, which meant those lucky enough to afford it had blisteringly fast upload and download speeds.

Then prices dropped through competition and more people plugged in and it wasn't long before speeds dropped through the floor. It may be just me being pedantic but if I sign up and pay twice what everyone else pays for a 25Mbps connection, I expect to get more than an average of 2Mbps. The quandary is that if I drop to a plan that offers 2Mbps, would I then get 128Kbps?

I'm not game enough to try, so I guess that's what keeps people on the high-end, big-money plans.

Clutched straws & black magic

Generally, by the time I resort to clutching straws or black magic, I'd have made the client aware of what is happening and that we are now in the realms of pure luck. I tell them that troubleshooting intermittent or technically difficult problems is a step-by-step process and sometimes it ends up being trial and error.

The "do-it-yourself" part reminds me of another issue serviceman often have to deal with. Many times we start working through a problem only to be interrupted at every turn by the client stating "I've already done that" or "that's what I did". What's more, it's often said in a way that implies that if we continue our tests, we would be insulting them or implying that they don't know

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The pain of staying beautiful

It really is quite surprising what goes on in beauty salons to keep one half of the population from looking like a dog's breakfast. This story comes from B. H. of Wollongong, NSW who sometimes gets to repair some of the gear they use . . .

I have a small electronic repair business that's involved mostly in TV and associated repairs but I also often see some more interesting equipment. For example, I have a customer with a beauty salon although she would much rather call it a "clinic".

Before I started doing jobs for her, I had no understanding of the variety and quantity of electronic equipment used to make women look more beautiful. Over the years, I have repaired lots of devices for her, from small delicate devices, right up to heavy industrial vibrators with a quarter-horsepower motor, to break up cellulite (what else?).

The last unit to come my way was a rather large and sophisticated machine manufactured by Carlton, a highly-regarded British company. The machine is called a "Dynatone" and although its name suggests that it would be more at home in an auto repair shop, its appearance would suggest something from the intensive-care unit of a hospital. It's basically a large, white console unit mounted on a trolley and it has lots of knobs, switches and lights. It also has a large number of long, flexible leads in pairs, attached to sticky pads.

Madame explained to me that her client laid on a bed next to the machine. The pads were then attached to various parts of the client's body and electrical pulses were applied in some kind of a sequence to the electrodes. The aim is to stimulate muscle tone and tighten up the skin and the the client would lay on the table for 30-40 minutes at a time, enduring (or maybe even enjoying) a series of small electric shocks.

The problem now was that the ladies were not feeling anything. In short, there was no output from the machine and so I was called in to fix it.

Back at the workshop, the scope confirmed that there was no output from the electrodes. Further investigation revealed that the circuitry was laid out on quite a few separate PCBs. I could easily identify the power supply and there was also a board with a small inductor and switching transistor for each electrode. In addition, there was a CPU board with a Z80 and EEPROMs, plus a few other boards.

The owner was able to tell me where she had originally purchased it, so I called them up only to be told that they no longer had the agency and that another company had taken it over. I called this second company but the machine pre-dated their involvement, so they couldn't help either.

When I told Madame that things were not looking good and that a repair may not be possible, she quickly informed me that she had purchased the machine for $14,000 about 10 years ago and that it was essential to her operation! She had no-one else to turn to, so I needed to get serious.

I decided to email the manufacturer in Britain and was really pleased with their help. The service manager explained that this machine was long obsolete and that they had no spare boards but he had found a copy of the circuit and emailed it to me. And that was a tremendous help.

I could now determine that most of the machine was fine. The only function of the CPU board was to generate the timing pulses and they were not present. Fortunately, I had lots of experience with the Z80 years ago, so I ran a few basic checks. The oscillator was running and there was lots of interesting waveforms on the bus but where do you go from there?

Then I had an idea. I could easily generate timing pulses using a PIC. I hooked up a PIC16F84 on a small board, set it to go through several sequences, one electrode at a time, rotate a bit, then two at a time, etc, before finally firing all at once.

It all worked well. How things have changed – one 16-pin chip could replace a board with about 12 chips.

The worst bit came when I decided to strap the electrodes on myself to see how it feels. I have spent a lifetime trying to avoid electric shocks and have an aversion to getting shocked, so this really was not my cup of tea.

On this machine, you can vary the intensity of the output and the operator does this to suit the client. I couldn't stand it after five on the intensity level.

And so the machine went back to the salon – sorry, clinic – but the clients were soon complaining that the shocks were not coming in big enough numbers. One at a time was no good; they wanted multiple shocks and after a little fine-tuning with the software, they were happy.

Only then did Madame tell me that she never set the intensity past two! And I'd been the guinea pig all the way up to five.

Of course, it's easy for us guys to be sceptical about the benefits but her clients are not. They really are confident it's doing them good and they are paying lots for the privilege. And would you believe it – I think it's made yours truly look at least 10 years younger!

what they are doing. And that means that the situation has to be handled professionally.

Watch if you want

My answer to this problem is to tell the client that while they have done everything correctly, we always follow a standard set of troubleshooting steps to confirm what we've been told. Most clients are chuffed about this and I also invite them to "watch if you want to".

Usually, if the job takes a while, they eventually get bored and drift off and do something else. However, unlike some technicians, I always let people watch if that's what they want to do. It can get a bit annoying at times but it makes them feel part of the process and that's always good for customer relations. SC

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- Kit includes: control panel, remote LED controller, PIR sensors, reed switch, bellbox, 50m 6 core cable and 12V 1.2Ah backup battery

LA-5560 WAS $299.00

$249.00

SAVE $50.00

Spare controllers and sensors also available:

LED Remote Controller	**LA-5561** $49.95
LCD Remote Controller	**LA-5563** $69.95
PIR Sensor	**LA-5564** $29.95

D1 RESOLUTION DVR KIT WITH 4 IR CAMERAS

NEW

Package includes digital recorder, four weatherproof colour cameras, and 500GB of storage for over 300 hours continuous video recording. With the help of a free app* for Smartphone/iPhone® or the internet, you can log into a system from anywhere to view live and/or recorded footage. See website for full specifications.

- H.264 video compression
- Advanced motion trigger recording
- Up to 704 x 576 pixel (D1) resolution
- CCD colour cameras with 420TV lines
- DVR size: 343(L) x 59(W) x 223(H)mm
- Power supply and 4x 20m cables included

QV-8106

NOTE: *Free app available to view live footage. Application based searching and backup requires advanced version at an additional cost.

$849.00

ON-LINE 1000VA 700W UPS

A UPS that provides a perfectly clean sine wave output no matter what the mains throws at it. Protected for surges, spikes, noise, brownouts and blackouts for as long as the batteries last. A backlit LCD shows the operating status and advises of any fault condition. It also provides an RS-232 interface so the UPS can be connected to a computer and used with the included management software.

- 2 x 240V outlets
- Input voltage: 150 to 280VAC
- Batteries: 2 x 12V 7Ah
- Backup time: 7 mins at 50% load
- Software included
- Size: 400(L) x 145(W) x 210(H)mm

MP-5210
WAS $599.00

$449.00

SAVE $150.00

SWITCHING REGULATOR KIT

Refer: Silicon Chip Magazine February 2012

Outputs 1.2 to 20V from a higher voltage DC supply at currents up to 1.5A. It is small, efficient and with many features including a very low drop-out voltage, little heat generation, electronic shutdown, soft start, thermal, overload and short circuit protection. Kit supplied with PCB, pre-soldered surface mounted components and PCB mount components.

- PCB: 49.5 x 34mm

KC-5508

$39.95

WEATHER STATION/CLOCK/PHOTO FRAME

Keep tab on the weather, the time and display photos of family and friends. A remote sensor sends weather data to the display unit which provides outdoor temperature, humidity, trend and forecast information and also displays indoor temperature. Photos can be loaded by PC, SD/MMC card or USB flash drive. Mains plugpack included.

- 12/24 hour clock with alarm
- Wall or desk mount
- Size: 200(W) x 150(H) x 30(D)mm

XC-0345 WAS $159.00

$129.00

SAVE $30.00

38CH UHF TRANSCEIVER

Featuring a 38 channel hand-held transceiver with up to 3km range. Perfect for camping, picnics in the bush, skiing and hiking trips. Requires 3 x AAA batteries.

BUY 2 FOR $30 SAVE $9.90

- Integrated Blue LED Torch
- Push to Talk (PTT) function
- Electronic volume control
- Scan channel, call tone and monitor functions.
- Low battery alert
- Duplex function
- Size: 122(H) x 54(W) x 35(D)mm

DC-1008

$19.95

5W VHF MARINE RADIO TRANSCEIVER

Powerful 5W hand-held transceiver gives you coverage of all International VHF marine channels. The antenna is detachable so units can be connected to a larger antenna mounted on a boat. Includes Li-Ion rechargeable battery pack, AC adaptor, charging cradle, 12VDC car cigarette lighter charger and belt clip.

NEW

- 1W/5W switchable output power
- LCD backlit display
- Dual and triple watch function
- Channel scan function
- Auto power saver mode

DC-1096

$199.00

2.4GHZ WIRELESS REVERSING CAMERA WITH 3.5" LCD MONITOR

A tough reversing camera system for cars, buses or trucks. Colour camera is waterproof, features infrared LEDs for night vision and transmits wirelessly up to 80m with no messy cables.

- Accepts up to 4 cameras.
- Includes 3.5" colour LCD and 1 camera
- Cigarette lighter or USB charger included

QM-3806

NEW

Spare 2.4GHz Wireless Reversing Camera available separately

QM-3807
$159.00

$299.00

7" COLOUR VIDEO DOORPHONE

NEW

Monitor the front door of your home or office without the need to run wires. The weatherproof outdoor camera can be powered from the included power supply or from 6 x AA batteries (not included). The AV signal transmits wirelessly to the 7" colour monitor. It also records any visitors you had while you were out, saving the vision to an SD card (available separately).

- 2.4GHz for clear transmission up to 100m

QC-3621

$349.00

Prices valid from 24/02/2012 to 23/03/2012. Limited stock on sale items. No rainchecks.

Pre-Catalogue Sale!

SLIDE/FILM SCANNER WITH LCD

So simple to use and it doesn't even need a computer to operate! Record images from your film negatives and slides. Load a card, load your negatives or slides into the image holder and start scanning.

- 5.1 MP Camera
- 3,600 dpi scan resolution
- Auto exposure and colour balance
- Powered via USB, 9V mains adaptor or 4 x AAA batteries
- Includes slide/film holders, and brush cleaner
- Size: 87(L) x 88(W) x 105(H)mm

XC-4891 WAS $149.00

$99.00 SAVE $50.00

Note: SD/MMC card not included

Limited Stock. Not available online.

150MBPS MICRO 802.11N USB 2.0 WIRELESS NETWORK ADAPTOR

A mini sized USB wireless network adaptor ideal laptops. Features MIMO technology for increased throughput and range, backward compatibility with 802.11b/g networks and the full spectrum of encryption and security features. Simple setup.

- Transfer speeds up to 150Mbps
- Compatible with Windows, Linux and MAC OS X
- Size: 21(L) x 21(W) x 7(H)mm

YN-8308
WAS $19.95

$14.95 SAVE $5.00

MINI USB SD CARD READER

SD cards are the most popular storage devices for digital cameras and just about every other device that uses portable storage. This low cost card reader has a SD slot on the side and is compact enough to take anywhere.

- USB 2.0
- No drivers required
- Size: 63(L) x 23(W) x 9(H)mm

XC-4756 WAS $8.95

$5.95 SAVE $3.00

Limited Stock. Not available online.

USB OPTICAL MOUSE WITH NUMBER KEYPAD

Simply plugs into the computer's USB port to give a full function numeric keypad and mouse. Lead length 700mm.

- Size: 67(W) x 110(L) x 20(H)mm

XM-5138 WAS $37.95

Also available: **IP68 Rated USB Optical Mouse**
XM-5139 WAS $39.95
NOW $14.95 SAVE $25.00

$17.95 SAVE $20.00

Limited stock. Not available online.

COLOUR DOME CAMERA KIT WITH 2-WIRE CONNECTION

A simple 2 wire combined arrangement for power and video make this system a snap to install. The system uses a CMOS image sensor with 350TV line resolution. The main unit will automatically sense signal cable tampering or incorrect wiring and alert you with a warning signal.

- Kit includes dome camera, system unit, 25m of connecting cable, and mains adaptor

QC-3264 WAS $129.00

$69.00 SAVE $60.00

Also available: **Outdoor version IR (IP56 rated)**
QC-3266 WAS $149.00 NOW $49.00 SAVE $100.00

Limited Stock. Not available online.

SURVEILLANCE CAMERAS

3MP Mini HD Digital Video Camera

Ultra portable, compact HD video camera and recorder has 2GB of internal memory that will hold up to 50 minutes of video (20 minutes in high definition) or over 3000 photos. Recharges via USB and it will give about 4 hours of use. Pocket clip and desk stand included.

- 350mAh rechargeable battery included
- Supports up to 32GB MicroSD card
- Weighs only 25g
- Size: 23(H) x 78(H) x 14(D)mm

QC-8005 WAS $119.00

$79.00 SAVE $40.00

LED Flashlight with HD Video Camera

Video can be recorded at 720p and the LEDs enable night time and low-light condition recording. Its compact size and features make it a handy tool for security guards or even for home surveillance applications. It also takes photos, accepts a MicroSD (up to 32GB) card and can be used as a USB storage device.

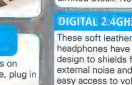
- Recording format: AVI
- Frame rate: 30fps
- Recording time: up to 4 hours
- Video compression: MJPEG
- Size: 111(L) x 32(D)mm

QC-8010 WAS $129.00

$79.00 SAVE $50.00

MICRO USB DIGITAL TV TUNER

Coupled with a laptop, you can enjoy your favourite TV programs from practically anywhere with this USB DVB-T Pico TV stick. Plug into a PC system and tune into your favourite programs with the included software.



- Free-to-air Digital TV (DVB-T)
- Supports time-shifting allowing you to pause live TV
- Supports scheduled recording
- USB 2.0 interface
- Supports High Definition Digital TV (HDTV)
- Includes mini MCX DVB-T aerial & remote control

XC-4897 WAS $89.95

$39.95 SAVE $50.00

Limited Stock. Not available online.

CASSETTE TAPE TO MP3 ENCODER WITH USB

Listen to old school retro-chic cassette tapes on your iPod®. Just install the included software, plug in the encoder and you're ready to convert music from your cassettes to digital MP3 or WAV format! Doubles as a handy dictaphone and tape player with built-in speaker.

- Windows compatible
- Power via 3VDC adaptor or 2 x AA batteries (not included)
- Size: 90(L) x 116(W) x 36(D)mm

GE-4053 WAS $89.95

$59.95 SAVE $30.00

Limited Stock. Not available online.

3W LED TACTICAL TORCH

Bulletproof machined aluminium construction and O-ring sealed for all the rigours of professional work. The sides are machined for a weapons mount and the tailcap has a tactical switch suitable for military, law enforcement and security work.
Requires 3 AAA batteries.

- Output: 120 lumens
- Size: 148(L) x 34(Dia.)mm

ST-3399 WAS $19.95

$9.95 SAVE $10.00

Limited Stock. Not available online.

WAFER CARDS

Fun Wafer Card
An ATMEL based smart card with a AT90S8515A and coupled with a 24LC256 EEPROM.
ZZ-8806 WAS $12.95
NOW $8.00 SAVE $4.95

$8.00 SAVE $4.95

Silver Wafer Card
A multi-chip smart card based on the PIC16F877 and coupled with a 24LC64 EEPROM.
ZZ-8810 WAS $19.95 NOW $8.00 SAVE $11.95

Emerald Wafer Card
A multi-chip smart card based on the PIC16F628 and coupled with a 24LC64 EEPROM.
ZZ-8820 WAS $14.95 NOW $8.00 SAVE $6.95

Limited Stock. Not available online.

DIGITAL 2.4GHZ WIRELESS HEADPHONES

These soft leatherette foam padded headphones have full ear cup design to shields from unwanted external noise and incorporates easy access to volume, power and tuning controls. Easy to use, just plug the transmitter into a computer, iPod® or any audio device for the convenience of wireless personal audio. The mains adaptor is used for powering the transmitter unit and also for recharging the headphones.

- Built-in volume control
- 3.5mm auxiliary input
- Mains plugpack/ charger included

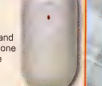
AA-2074 WAS $99.00

$69.00 SAVE $30.00

MOTION DETECTORS

Dual Infra-Red & Microwave Motion Detector

This dual technology sensor provides the highest detection reliability by combining both IR and microwave motion detectors in one compact and attractive unit. The sensor will only signal an alarm when both detectors provide simultaneous intrusion signals.



- Size: 132(H) x 72(W) x 57(D)mm

LA-5039 WAS $89.95

$69.95 SAVE $20.00

360 degree Pulse Count PIR

This motion detector employs an omni-directional infrared sensor and a reliable electronic circuit to provide reliable 360° intruder detection. It can cover up to 15m and is ideal to expand an existing alarm system or for a new system that requires comprehensive PIR coverage.

- Power: 9 -16VDC
- Size: 110(Dia.) x 44(H)mm

LA-5041 WAS $169.00

$149.00 SAVE $20.00

Pre-Catalogue Sale!

Network 4 Channel 10" LCD DVR and Camera Kit

The package incorporates a H.264 DVR with built-in 10" LCD monitor and 320GB HDD, 2 indoor/outdoor CMOS 350TVL colour cameras with IR illumination for night viewing, 2 x 18m cables and power supplies. Recording can be started manually, by programming or by triggered alarm conditions. The main feature is the Smartphone support and the free iPhone® app* you can download from iTunes® to view live or recorded footage. Monitoring may be done real-time on a monitor, LAN network, via internet or Smartphone. The DVR functions can be controlled by mouse or the IR remote control.

- DVR/Screen size: 208(L) x 86(W) x 242(H)mm
  Camera size: 115(L) x 45(H)mm

QV-3030 WAS $699.00

$649.00
SAVE $50.00

*App is free for single use and may incur a charge for multi-user

CHILD / PET DOOR ANNUNCIATOR

Keep your children and pets safe with this PIR sensor alarm gate. Simply mount at any entrance and the alarm will sound for 30 seconds every time your child or pet passes through.

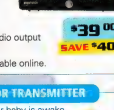
- Unit measures 1 metre when assembled
- Requires 3 x AA batteries

LA-5166 WAS $49.95

Limited stock. Not available online.

$19.95
SAVE $30.00

3 SPEED BELT DRIVE TURNTABLE WITH ANALOGUE AND USB AUDIO OUTPUT



Perfect to play those old vinyl records on and also makes back-up copies in a convenient digital format via its USB connection. The turntable plays singles, EPs, albums and even old 78s.

- 33/45/78 rpm
- Mains powered
- Magnetic cartridge
- NAB centre adaptor
- Analogue or digital audio output

GE-4059 WAS $79.00

$39.00
SAVE $40.00

Limited stock. Not available online.

UHF BABY MONITOR TRANSMITTER

Know exactly when your baby is awake, needs changing or feeding. With voice activation (VOX), you'll be alerted on the remote unit. Will transmit over a much greater distance than a traditional baby monitor, up to 500 metres!

- Keypad lock
- Rechargeable batteries and charger included
- 38 channel
- Unit size: 140(H)mm

DC-1024 WAS $69.00

$29.00
SAVE $40.00

COMPACT DAB+ & FM RADIO TUNER

Tune into crystal clear digital radio. Perfect for the bedside table or on the kitchen window sill, it can even be taken out and run off batteries. The LCD clearly displays the time, date and station ID. Alarm mode, 10 station memory and stereo headphone output. Requires 4 x AA batteries or the included AC adaptor.

- DAB+/FM
- Backlit 2-line LCD
- Headphone socket
- Size: 178(W) x 76(W) x 40(D)mm

AR-1751 WAS $89.00

$45.00
SAVE $44.00

Limited stock. Not available online.

HANDHELD MICRO INSPECTION CAMERA 17MM

Allows you to perform a detailed visual inspection in hard to reach areas. Its pistol grip design and detachable wireless 2.4GHz monitor make it easy to locate and diagnose the unreachable. Monitor features composite video out for connection to a larger screen. See website for full specs.

- 2.5" TFT-LCD
- CMOS image sensor

QC-8700 WAS $229.00

$199.00
SAVE $30.00

Also available: **2m Gooseneck Extension QC-8702** $99.00

35MM PHOTO FRAME KEYRING

Holds up to 100 photos which can be downloaded from a MAC or PC. Unit features an LED torch and comes with a stand and mini USB lead.

- Overall size: 68(L) x 42(W) x 13(D) mm (glossy black)

XC-0211 WAS $24.95

$19.95
SAVE $5.00

38CH UHF CB RADIO

Lightweight hand-held transceiver suitable for all professional and recreational activities such as camping etc. Transmission range is up to 5km, with city range up to 1km.

- Covers Australian 38 UHF CB channels and repeaters
- Size: 105(H) x 60(W) x 35(D)mm

DC-1023 WAS $49.95

$24.95
SAVE $25.00

Limited stock. Not available online.

HANDHELD USB 60X MICROSCOPE

A colour zoom CMOS video camera mounted in a microscope style housing. The system connects to a computer via the USB port and microscope images are viewed on the screen as either a snapshot or a video stream. Accessories include specimen slides, eye dropper and tweezers.

- Up to 640 x 480 image resolution
- Maximum magnification 60x
- Size: 100(L) x 38(Dia.)mm

QC-3248 WAS $59.95

$19.95
SAVE $40.00

Limited stock. Not available online.

TESTER & METER

Automotive Blade Fuse Current Meter

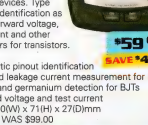
The quick and easy way to measure current in automotive circuits. Simply slot the adapter into the blade fuse holder and take a current measurement. Adapters for standard, mini and maxi size fuses.

- Peak hold and data hold
- Analogue/3 1/2 digit digital display
- Size: 112(L) x 45(W) x 33(D)mm

QP-2257 WAS $99.00

$59.00
SAVE $40.00

Semiconductor Component Analyser



Intelligent semiconductor analyser that offers simple identification and testing of a variety of 2 or 3-pin devices. Type and lead identification as well as forward voltage, test current and other parameters for transistors.

- Automatic pinout identification
- Gain and leakage current measurement for BJTs
- Silicon and germanium detection for BJTs
- Forward voltage and test current
- Size: 100(W) x 71(H) x 27(D)mm

QT-2216 WAS $99.00

$59.00
SAVE $40.00

FOUR CHANNEL SURVEILLANCE VIDEO RECORDING CARD

This four channel video recording card incorporates high speed real time compression and digital motion detection, alarm event recording and logging, variable compression, and mixed frame rate recording.

- Digital video recording
- Remote viewing via TCP/IP IPX
- Multiple camera display mode
- 4 camera inputs, 2 audio inputs
- Overall frame rate: 30fps
- Supports Win2000/ Win XP

QV-3080 WAS $179.00

$99.00
SAVE $80.00

Also available:
8 Channel Video Recording Card
QV-3082 WAS $249.00
NOW $149.00 SAVE $100.00
Limited stock. Not available online.

2.4GHZ DIGITAL WIRELESS SPEAKERS

With a 30m range the audio transmitter is 2.4GHz DIGITAL, which ensures noise-free transmission. The speakers have mood lights, but can be switched out. Each speaker has its own power adaptor but will operate completely wirelessly on 6 x AA (batteries not supplied). The transmitter can be driven via a micro USB (which also powers it) or by a power adaptor (supplied).

- Speakers: 250(H) x 130(Dia.)mm
- Transmitter: 90(Dia) x 35(H)mm

AR-1891 WAS $169.00

$149.00
SAVE $20.00

Pre-Catalogue Sale!

SUPER SAVINGS!

Weatherproof Bellbox Siren/Strobe Light 12V

Designed for outdoor alarm applications, this unit has a strobe light and two piezo sirens. Operates on 12VDC from an external alarm source and terminates by 600mm flying leads. Suitable for caravans, boats, garages etc.

- Current consumption: 100mA (strobe). 90mA (siren)
- Siren SPL: 105dB(A)
- Size: 105(L) x 105(W) x 39(D)mm

LA-5309 WAS $29.95

$9.95 SAVE $20.00

Limited stock. Not available online.

RFID Keypad Access Controller

A card capacity of up to 500 RFID cards designed to control door strikes in home or business access control installations. The unit allows 4 entry method, password, proximity card, password + proximity card and egress push button entries.

LA-5123 WAS $169.00

$59.00 SAVE $110.00

Limited stock. Not available online.

ADVANCED 2 WATT 38 CHANNEL UHF TRANSCEIVER WITH CTCSS

This high-quality transceiver provides a range up to 10km line-of-sight suiting many professional and leisure activities. Save battery power by switching to the low setting (500mW) for local communications. Includes rechargeable Li-Ion battery and plugpack charger.

- CTCSS function
- Power output: 2W
- Hi/Lo power output
- Size: 120(L) x 57(W) x 35(H)mm

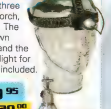
DC-1047 WAS $99.95

$79.95 SAVE $20.00

NOTE: CTCSS (Continuous Tone-Coded Squelch System) allows users on a shared channel to reduce interference from other users by filtering them out. Limited stock. Not available online.

SOLAR POWERED LED BICYCLE TAIL LIGHT

This solar powered tail light is a simple and versatile addition to your night riding equipment. The device uses 4 red LEDs that blink in unison creating an easily visible beacon to cars and trucks.



- Size: 64(W) x 65(H)mm

ST-3276 WAS $23.95

$9.95 SAVE $14.00

Limited stock. Not available online.

LED TORCH KIT

Configure the light in any of three different ways: a hand-held torch, headlamp or a handy lantern. The head torch comes with its own battery pack and head band and the lantern makes the ideal tent light for camping. Lanyard and tripod included.

- Requires 1 x CR123A, 2 x AA batteries
- Output 120lm
- Size: 98(L)mm

ST-3391 WAS $69.95

$49.95 SAVE $20.00

MOTORISED FLAT TV BRACKETS

With the touch of a button, swivel or tilt your LCD or plasma TV either manually or to a pre-programmed position. The mount will fit standard VESA 200, 300 or 400mm and with a specified operating noise level of 25dB. Ideal for TVs that are concealed behind panels or TVs in commercial environments like pubs, waiting rooms, clubs or conference rooms etc. Remote control included.

30kg

- Projection distance: 150mm
- TV weight: 10 - 30kg

CW-2835 WAS $299.00

$199.00 SAVE $100.00

50kg

- Projection distance: 180mm
- TV weight: 30 - 50kg

CW-2837 WAS $499.00

$359.00 SAVE $140.00

MP3 STEREO EARPHONES

Economically priced earphones to use with your MP3 player. The light, modern design makes these easy to use wherever you are.

- Driver size: 15mm
- Resistance 32 ohm
- Sensitivity: 112dB

AA-2080 WAS $9.95

$5.95 SAVE $4.00

WIRELESS SURROUND SOUND STEREO HEADPHONES

These 900MHz UHF wireless headphones feature a simulated surround-sound function and operates all around the house without messy cables. Simply sit the transmitter near the music source and plug it in. Also features 3 automatic channels and phase locked loop (PLL) technology to avoid any reception drift. The transmitter is powered by the supplied plugpack that also acts as a charging base for the headphones. The headphones operate from 2 x AAA rechargeable batteries (supplied).

- Soft padded ear cups
- Transmission range: 15m

AA-2070 WAS $99.95

$49.95 SAVE $50.00

DELUXE MAINS POWER METER WITH CO_2 MEASUREMENT

This meter tells you the cost of electricity consumption of an appliance plugged into it and the amount of power used in kilowatt hours, as well as how many cumulative kg of CO_2 the appliance is putting into the atmosphere.

- Extra large LCD for easy reading
- Size: 120(L) x 58(W) x 40(H)mm

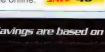
MS-6118

$29.95

BUY 2 for $50 SAVE $9.90

LIGHT LANTERN LED WITH SOLAR CHARGER PSU ADAPTOR

A super bright white LED lamp with an integrated compass. Can be charged via mains power, car charger or by the unit's solar panel.



- Mains and car chargers supplied
- 2.5Ah/6V sealed maintenance free lead-acid battery
- Lamp size: 250(H) x 108 (Dia.)mm

ST-3128 WAS $99.95

$59.95 SAVE $40.00

Limited stock. Not available online.

MULTIFUNCTION 200W INVERTER

Housed in a tough rubberised case, ideal power accessory for your next camping fishing or 4WD adventure. Features a USB outlet, an LED work light and two 12V cigarette lighter outlets.

- 200W modified sine wave inverter
- Size: 230(W) x 180(H) x 62(D)mm

MI-5103 WAS $69.95

$49.95 SAVE $20.00

COMPUTER ACCESSORIES

Tiny 300k Notebook USB Webcam

Excellent for on-the-go online video conferencing or chatting. It has a built-in microphone to keep setup to a minimum. Mounts on top of a thin LCD laptop screen.

- Driverless, plug and play
- Size: 28(W) x 59(H) x 14(D)mm

QC-3231 WAS $19.95

$14.95 SAVE $5.00

Also Available:

2MP Web Camera with Microphone

QC-3233 WAS $29.95 NOW $24.95 SAVE $5.00

Mini Roll-Up Wireless Keyboard

Convenient size with splash resistant keypad ideal for harsh environments or areas that have to be constantly cleaned such as sawmills, factories, workshops and food preparation areas.

- Standard QWERTY layout
- Washable and hygienic
- Supports Windows
- Size: 370(L) x 123(W) x 15(H)mm

XC-5145 WAS $49.95

$29.95 SAVE $20.00

Wireless USB Trackball Remote Control for PC Media Centres

The trackball works as a mouse or any other pointer device and you can type numbers or text in the same way you do with a mobile phone. It also has quick-launch keys, plus controls for multimedia use - play, pause, record etc. You can also program macros or single commands into any key. Requires 2 x AA batteries.

- 2.4GHz
- 10m range
- 19mm optical trackball & mouse keys
- USB dongle receiver
- Windows compatible
- Size: 180(L) x 50(W) x 30(H)mm

XC-4940 WAS $89.00

$59.00 SAVE $30.00

To order call 1800 022 888

All Savings are based on Original RRP. Limited stock on sale items.

Pre-Catalogue Sale!

SAVINGS ON SECURITY CAMERAS

Dome Camera Vari-Focal 480TVL w/ Bracket

Housed in a strong die-cast aluminium base with an L-shaped bracket and a reinforced polycarbonate dome, this 480TV lines vari-focal camera is designed to withstand the harshest of environments.

- Manual focus 3.5 - 8mm CS type lens

QC-3287 WAS $299.00

$139.00 SAVE $160

Limited stock. Not available online.

ExView HAD Colour CCD Camera - Pro Style

A high performance colour CCD surveillance camera which captures detailed flickerless video footage even in the lowest of light levels. Features auto iris control, auto white balance, 2 stage automatic gain control and back light compensation.

- Sony ExView 1/3" HAD CCD Sensor
- 380TVL, 500 x 582p resolution
- Minimum illumination: 0.05 lux
- Shutter speed: 1/110,000 (sec)

QC-3298 WAS $249.00

$109.00 SAVE $140

Limited stock. Not available online.

USB SLIDE/FILM SCANNER

Easy DIY way of digitally archiving, sharing and saving cherished photos. Negative and slide holders included.

$49.00 SAVE $25.00

- Scan directly to your PC using the provided software
- 1,800dpi resolution
- Windows compatible
- Size: 85(W) x 165(H) x 90(D)mm

XC-4881 WAS $74.00

COMPUTER TOOL KIT

All the essentials for doing some minor surgery to your PC. The bit handle extends to 200mm for getting at those hard to reach screws.

Kit contents:

- Driver bit handle
- Bits: Slotted 3mm, 4mm, PH 0, 1,T10, T15
- Hex adaptors: 4mm, 5mm
- Tweezers , IC extractor, pearl catch

TD-2150 WAS $19.95

$9.95 SAVE $10.00

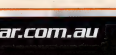
Limited stock. Not available online.

METERS ON SALE!

Autoranging SMT DMM

Specifically designed for SMT work with interchangeable probes and tweezer probes.

$39.95 SAVE $30.00



- Autoranging
- Continuity test
- Auto power-off
- SMT probes
- Display: 6000 count
- Size: 110(H) x 36(W) x 21(D)mm

QM-1496 WAS $69.95

CATIV Fixed Jaw Clampmeter

The ideal test instrument for electrical contractors. Compact and light with probe storage in the back for easy one-handed operation. Jaw opening is 16mm.

- Non-contact voltage sensor
- Data hold
- Auto power-off
- Diode test
- Audible continuity test
- Category: CATIV 600V, CATIII 1000V
- Display: 2000 count
- Size: 190(H) x 62(W) x 42(D)mm

QM-1567 WAS $179.00

$99.00 SAVE $80.00

VIFA SUBWOOFERS

These subwoofers produce genuine high fidelity sound quality and oustanding performance. With dual voice coils, high power handling and die-cast aluminium chassis, they don't just deliver brilliant low register bass clarity but also thump tremendous SPLs like only VIFA speakers can.

- Nominal impedance: 2 x 4 ohms

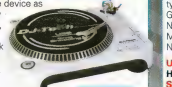
10" 200WRMS CS-2351 WAS $249.00 NOW $169.00 SAVE $80.00

12" 250WRMS CS-2353 WAS $299.00 NOW $199.00 SAVE $100.00

From **$169.00** SAVE $80.00

USB TURNTABLE WITH USB DIRECT ENCODING

Transfer your vinyl collection directly to your USB storage device as MP3 files. Simply play your records, plug your USB device in and click record. Finished in chrome and black.



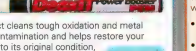
- 2 speed belt drive turntable
- Anti-skating control
- Motor off and reverse function
- RCA Phono/line output
- Size: 449(W) x 145(H) x 370(D)mm

AA-0494 WAS $249.00

$199.00 SAVE $50.00

Limited stock. Not available online.

DEOXIT PROGOLD CONTACT CLEANER & REJUVENATOR - PEN STYLE



This product cleans tough oxidation and metal sulphide contamination and helps restore your equipment to its original condition, improving its performance.

NS-1430 WAS $19.95

$9.95 SAVE $10.00

Limited stock. Not available online.

WINDSCREEN MOUNT SUCTION BRACKETS FOR iPHONES®

A handy device that mounts an iPhone® to the windscreen for easy access. The strong 80mm diameter suction mount will keep the iPhone® securely attached. Features a ball and socket joint for the best position.

For iPhone® 3 (with or without cover)

HS-9004 WAS $19.95 NOW $9.95 SAVE $10.00

For iPhone® 4 (without cover)

HS-9008 WAS $19.95 NOW $9.95 SAVE $10.00

$9.95 SAVE $10.00

CAUTION: Always ensure it is mounted so that it does not obstruct your view or cause a distraction.

*iPhone® not included

GPS SUNSHADES

Simply clip to the top of your GPS unit. Different types to fit popular in-car GPS models: Garmin Nuvi, TomTom Go, Magellan Maestro, Navman etc.

$9.95 SAVE $5.00

GPS not included

Universal Sunshade 3.5"

HS-9005 WAS $14.95 NOW $9.95 SAVE $5.00

Sunshade for TomTom 4.3"

HS-9006 WAS $19.95 NOW $9.95 SAVE $10.00

Sunshade for Garmin 4.3"

HS-9007 WAS $19.95 NOW $9.95 SAVE $10.00

SAVINGS ON CLOCKS!

Solar Powered Alarm Clock with Laser Projection

Project the time on your wall or ceiling! A sleek matt-silver finished alarm clock with clear LCD time, calendar and temperature display. It projects the time when the alarm goes off or when you press the button.

- 12/24 hour time and °C/°F temperature
- 2 x AAA batteries (not included) with solar cell to prolong battery life
- Size: 166(L) x 35(W) x 110(H)mm

XC-0214 WAS $24.95

$14.95 SAVE $10.00

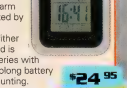
Also available:

LCD Calendar Alarm Clock with Solar Cell

XC-0213 WAS $19.95 NOW $9.95 SAVE $10.00

Solar LCD Clock with Calendar & Temperature

Easy-to-read large numerical time format. Features alarm function, is complemented by a calendar date and temperature display in either Celsius or Fahrenheit and is powered by 2 x AA batteries with auxiliary solar cells to prolong battery life. Suitable for wall mounting.



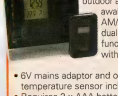
- Size: 250(H) x 250(L)mm

AR-1761 WAS $34.95

$24.95 SAVE $10.00

Multifunction Radio Alarm Clock

Projects the time and outdoor temperature on the ceiling and it has six realistic nature sounds that create a true-to-life outdoor ambience. Peacefully awaken in the morning to the AM/FM radio which includes dual alarms with snooze function and blue backlit LCD with low/high settings.



- 6V mains adaptor and outdoor temperature sensor included
- Requires 2 x AAA batteries
- Size: 160(W) x 180(H) x 42(D)mm

AR-1755 WAS $49.95

$34.95 SAVE $15.00

Jaycar Electronics

Better, More Technical

Kits for Kids

ETHANOL BIO FUEL ENERGY KIT

Generate your own electricity from ethanol (ethyl alcohol) using Direct Ethanol Fuel Cell technology. The kit contains everything you need to get your alternative fuel experiment off the ground, except the ethanol itself. Just use a solution of denatured alcohol which is available from pharmacies, hardware stores or chemical suppliers.

$50.00
SAVE $149.00
Over Half Price!

- Kit includes Ethanol storage tank, tubing, purging valve, supporting base, electric motor, wiring with croocdile clips, fan blades, Ethanol solution mixing container and pH measuring strips.
- Recommended for ages 12+

KT-2550 WAS $199.00

MINI 3 CHANNEL RC HELICOPTER

An entry-level chopper for the first time flier. 3 channel means you don't have too many controls to think about so you'll be up and flying in no time. Robustly constructed to take the inevitable bumps and occasional crash. 20 minute charge gives about 10 minutes flying time and the chopper recharges directly from the remote unit.

$24.95
SAVE $5.00

- Requires 6 x AA batteries
- Size: 160(L)mm approx.
- Recommended for ages 8+

GT-3306 WAS $29.95

MINI SOLAR RACE CARS

Fun & functional mini solar race car kit with built-in electric motor. No glue required - simply snap all the pieces together. The sun or a 50W halogen globe powers both models.

Buy 1 get 1 FREE

- Size 60(L)mm
- Recommended for ages 10+

Red	GT-3755	$9.95 ea
Green	GT-3756	

DUAL BRUSHLESS RC RACING HOVERCRAFT

Capable of ridiculous speeds, massive power slides, high speeds drifts. Two brushless ducted fan motors are responsible for the power, one blowing downwards to generate lift, and the second (and more powerful) motor providing the forward thrust.

$99.00
SAVE $150
Over Half Price!

- 2.4GHz RC unit included
- Li-Po battery and charger included
- Suitable for ages 8+
- Size: 193(L) x 280(H) x 113(W)mm

GT-3740 WAS $249.00

NOTE: These units are not recommended for use in water they are only to be used on land.

6 IN 1 SOLAR EDUCATIONAL ROBOT KIT

Introduce your kids to the world of solar power. This kit includes all the parts needed to construct up to six different projects of their choosing. Everything snaps together for easy assembly and its all solar powered so no batteries are required.

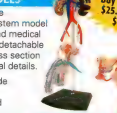
NEW

$19.95

- Suitable for ages 10+
- Projects include: robot, helicopter, plane, windmill, airboat and three wheeler
- Windmill size: 185 x 185 x 190mm

KJ-8936

INFRARED REMOTE CONTROLLED ROBOTIC BEETLE



Supplied as a kit of parts and once assembled, the beetle will scurry around and pick up small objects with its controllable claw. It has forward and reverse drive capability and can be steered around obstacles.

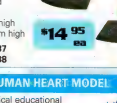
- Lifting robotic claw
- 100g lift capacity
- Fully steerable
- Requires 8 x AA batteries

KJ-8914 WAS $49.95

Limited stock. Not available online.

$39.95
SAVE $10.00

4D REPRODUCTIVE SYSTEM MODELS



Male and female reproductive system model for education and medical study. Includes detachable organs with cross section parts and internal details.

Buy both for $25.00 SAVE $4.90

- Assembly guide included
- Recommended for ages 8+
- Male: 246mm high Female: 160mm high

Male	GG-2387	$14.95 ea
Female	GG-2388	

1:1 SCALE HUMAN HEART MODEL

Perfect for medical educational purposes. Includes detachable tricuspid valve and mitral valve as well as detailed parts of the aorta, pulmonary artery, superior vena cave, inferior vena cave and septum.

- Display stand included
- 210mm high
- Recommended for ages 8+

GG-2378 WAS $49.95

$34.95
SAVE $15.00

MINI DESKTOP WIND GENERATOR WITH LED

Blow on the rotor blades and create electricity to power two blue and one green LED. Made from durable ABS plastic.

- Blade diameter: 60mm
- ABS plastic stand height 170mm
- Ideal wind speed around 9.6km per hour if used outdoors
- Suitable for ages 3+

GT-3752 WAS $19.95

$14.95
SAVE $5.00

MINI 3 CHANNEL IR ALUMINIUM HELICOPTER WITH GYRO

All aluminium airframe makes for a very robust mini chopper. Features a built in gyroscope which provides stable flight and makes it easy to fly even for the novice pilot. Recharging is via any USB port.

- 3 channel
- 25 minute recharge gives about 10 minute flight time
- 3.7V Li-po battery included
- Remote requires 6 x AA batteries
- Recommended for ages 14+
- Size: 190(L)mm approx.

GT-3310

BUY 2 FOR $70.00 SAVE $9.90

$39.95

Spare parts available. See in-store or online for info.

NEW KITS FOR KIDS

Smart Dark Line Tracer Kit

NEW

Assemble this robot and watch it dutifully follow a thick dark line before it.

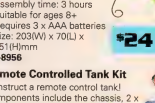
- Assembly time: 5 hours
- Suitable for ages 8+
- Requires 3 x AAA batteries
- Size:105(W) x 170(L) x 125(H)mm

$24.95

KJ-8954

Smart Bumper Bug

NEW



Assemble this big green 6 legged bug and watch it alter it's course before hitting a wall.

- Assembly time: 3 hours
- Suitable for ages 8+
- Requires 3 x AAA batteries
- Size: 203(W) x 70(L) x 151(H)mm

$24.95

KJ-8956

Remote Controlled Tank Kit

NEW

Construct a remote control tank! Components include the chassis, 2 x tracks, the hull, a turret and 2 gun tubes, one gun support and all the wheels. Assemble the pieces and you will have a fully functioning tank ready to roll out!

- Assembly time: 20 mins
- Suitable for ages 8+
- Requires 6 x AAA batteries
- Size:105(W) x 170(L) x 125(H)mm

$34.95

KJ-8950

Remote Control Robot Kit

This little robot kit includes a collection of components ready to assemble on the kitchen table. Once complete you will have a fully remote controlled robot unit.

NEW

- Assembly time: 10 - 20mins
- Suitable for ages 8+
- In total 6 x AAA batteries required for main unit and remote
- Size: 125(H)mm approx.

$34.95

KJ-8952

To order call 1800 022 888

All Savings are based on Original RRP. Limited stock on sale items.

1KG DIGITAL BENCH SCALE

NEW

Precision 1kg electronic scale with resolution of 0.01g for when a high degree of accuracy is required. Weighs in grams, ounces, pounds, grains, carats, troy ounces. Supplied with a wind shield and a built-in bubble level to provide maximum accuracy. Powered by 4 x AA batteries (not included) or mains adaptor.

- Auto power-off after 60 seconds
- Automatic calibration
- Backlit LCD
- Tare and counting function
- Mains powered
- Size: 175(W) x 75(H) x 260(D)mm

QM-7264

$149.00

USB PLASMA BALL

As the ball becomes energised, the gases inside light up and turn into plasma. By touching the outside of the ball, you can produce amazing effects.

- Size: 130(H) x 100(W)mm

$19.95

GE-4089

Note: Laptop not included

FAN WITH DETACHABLE WATER SPRAY

Keep cool while outdoors on your holiday or keep in the sports bag to use after a big workout. Can also be used as a normal fan by removing the water bottle.

$4.95

SAVE $4.00

- Requires 2 x AA batteries

GH-1073 WAS $8.95

SHIATSU NECK MASSAGER WITH VIBRATION & HEAT

Soothe tired neck muscles with a deep and relaxing massage in the comfort of your home or office. Relieve stress and tension with 3 massage modes - Shiatsu, vibration or Shiatsu & vibration.

- Heat mode
- Mains powered
- Size: 340(L) x 300(Dia.)mm

GH-1764 WAS $79.95

$69.95

SAVE $10.00

MINI 3MP DIGITAL VIDEO CAMERA

Capture good quality shots and recordings with this mini digital camera. Supports audio and video recordings onto a micro SD card (not included) and includes a USB cable to download images/recordings to a PC.

- 3.0 Megapixel
- Resolution: 1280 x 960 pixels
- Supports video, camera & audio
- USB powered
- Built-in microphone
- Size: 43(L) x 11(W) x 30(H)mm

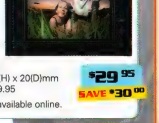
QC-3196

Limited stock.
Not available online.

$29.95

3.5" DIGITAL PHOTO FRAME

Displays single frame photos or slideshows and can read from an SD or MMC card up to 2GB. USB or mains powered.



- Supports JPEG image format
- Plugpack included
- Size: 108(W) x 84(H) x 20(D)mm

QM-3779 WAS $59.95

$29.95

SAVE $30.00

Limited stock. Not available online.

INTERACTIVE MUSIC QUIZ

Test your family and friends music knowledge with this interactive music quiz that you control! Game options include 'name that track', 'beat the intro', 'name the artist' and 'sing the next line'. Or make up your own game - the possibilities are endless!

- Requires 3 x AA batteries
- Suitable for ages 8+

GE-4233 WAS $39.95

$24.95

SAVE $15.00

RECHARGEABLE LED LANTERN 0.5W

Ideal for home use, outdoor sports and camping etc. It's weatherproof suited for emergency situations or during periods of extreme climate conditions where lighting is essential. Incorporate three lighting options and has the ability to control the mode and brightness by rotating the knob. Supplied with cigarette lighter socket, mini USB cable and 3xAAA rechargeable batteries.

- 360° rotating mode switch
- 6 x LED Lantern
- 0.5W LED Torch
- Size: 62(L) x 140(H) x 31(D)mm

ST-3121 WAS $34.95

$24.95

SAVE $10.00

HORN STAND AMPLIFIER

This moulded silicone horn holds your iPhone4® and amplifies the sound up to 13dB.

NEW

- Colours available pink, white, green and blue

XC-5173

Note: iPhone® not included

$9.95

HEALTH CONSCIOUS!

Automatic Blood Pressure Monitor

Monitor blood pressure and heart rate. Designed to take accurate blood pressure readings from the wrist and calculate the average blood pressure. Requires 4 x AA batteries.

- Uses the oscillometric method
- Arrhythmia detection function (IHB)
- Calculate average measurements
- Stores readings for up to 3 individuals

QM-7254

$49.95

Stethoscope

Buy both for $55.00 SAVE $9.90

Ideal for medical applications or to listen for mechanical noises in equipment. A very handy diagnostic tool with plenty of non-medical uses.

QM-7255

$14.95

KITCHEN VOICE RECORDER

Ideal for shopping lists, as a reminder for the kids or even to record the ingredients in those quick cooking commercials. Strong magnetised backing.

- 3 folders up to 50 messages
- Digital clock
- Requires 2 x AA batteries
- Size: 130(L) x 66(H) x 17.2(W)mm

XC-0249 WAS $69.95

$39.95

SAVE $30.00

PINK PRODUCTS

USB Pink Keyboard with Optical Mouse Kit

Featuring 21 hot keys including three ACPI keys for easy access to the internet, email and multimedia applications.

- Size: 30(H) x 480(W) x 180(D)mm

XC-5151 WAS $35.00

Limited stock. Not available online.

$20.00

SAVE $15.00

Stapler with Pink Rhinestones

What better way to jazz up your desk than with this glittering rhinestone-finished desk stapler

- Takes size 56 staples
- Size: 160(L) x 39(W)mm

GH-1894 WAS $19.95

$9.95

SAVE $10.00

23 Piece Mini Pink Tool Kit

For the woman that likes to be prepared for every situation, here's a mini tool kit she can take anywhere. 23 pieces in total.

TD-2067 WAS $19.95

$14.95

SAVE $5.00

Also available:
149 Piece Pink Tool Set
TD-2075
WAS $49.95
NOW $39.95
SAVE $10.00

STORAGE MEDIA

Micro Thumbdrives

Super slim USB Micro thumb drive that measure only 32mm long and less than 3mm thick. Attach to your keyring and have a memory card wherever you go.

From $9.95

- Windows and MAC compatible
- Plug and Play
- USB 1.1 and 2.0
- 5 year warranty

NEW

4GB XC-5610 $9.95
8GB XC-5612 $13.95
16GB XC-5614 $24.95

Flucard® PRO Wireless SD Card - 8GB

Gives a whole new dimension to capturing, storing and sharing of photos and videos wirelessly. Transfer and share precious moments from your digital camera to your PC, laptop, tablets or Smartphones. See website for full features and specifications.

- 8GB storage for approx. 3000 photos (varies based on photo size)
- Plug & Play

XC-5620

NEW

$99.00

ALL IN-ONE CARD READER WITH 6 SLOTS AND USB HUB

As well as being able to read a multitude of formats, it has a flip top to store a number of micro, SD or XD cards. Has two port USB 2.0 hub and store for the USB cable.

- Ideal for roving photographers
- Size: 87(L) x 39(W) x 18(H)mm

XC-4924 WAS $24.95

$9.95 SAVE $15.00

Limited stock. Not available online

WHITE ILLUMINATED ROLL-UP KEYBOARD

This QWERTY keyboard rolls up for easy transportation or storage and is waterproof. You can spill coffee on it and it won't miss a beat. Perfect for workshops, garages, food preparation areas and travellers.

XC-5147 WAS $49.95

$24.95 SAVE $25.00

Limited stock. Not available online.

SD/MMC CARD WEBSERVER IN A BOX

Host your own website on a common SD/MMC card with this compact Web server In a Box (WIB). Connecting to the Internet via your modem/router, it features inbuilt HTTP server, FTP server, SMTP email client, dynamic DNS client, RS232 serial port, four digital outputs and four analogue inputs. Requires a SD memory card, some SMD soldering and a 6 - 9VDC adaptor. Kit includes PCB, case and electronic components.

- PCB Dimensions: 123 x 74mm

XC-5489

$89.95

150MBPS NANO 802.11N USB 2.0 WIRELESS NETWORK ADAPTOR

NEW

At only 5mm wide, this is the tiniest USB 2.0 network adaptor out there. Capable of up to 150Mbps ideal for the PC, laptop, or netbook.

- 802.11n
- Size: 15(L) x 5(W) x 17(D)mm

YN-8309

$21.95

MINI WIRELESS KEYBOARD WITH TRACKBALL

NEW

Features the full QWERTY key layout, a brilliant little trackball and mouse scroll wheel. Operates on 2.4GHz band for easy wireless access. Includes nano sized USB dongle.

- Requires 2 x AAA batteries
- Size: 261(L) x 112(W) x 30(H)mm

XC-4943

$49.95

5.5" GRAPHICS TABLET

More comfortable and far more accurate than a mouse with higher resolution and pressure sensitivity. Paint, draw, write or touch up. Ideal for graphics designers, photographers or other creatives.

- Battery and software included
- Windows 2000, XP, Vista or Mac
- Size: 205(W) x 190(H)mm

XC-0356 WAS $59.95

$49.95 SAVE $10.00

3-IN-1 USB MICROSCOPE

Use it as a conventional optical microscope, a digital microscope or snap the USB camera into the top and capture images to your PC or MAC. It comes with slides and tools for manipulating your scientific projects.

- Software included
- Magnification: 50 - 100x, 100 - 200x, 200 - 400x
- Suitable for ages 10+
- Size: 112(W) x 132(D) x 260(H)mm

QC-3241 WAS $89.00

Also available: **Power Microscope Kit with reflecting and transmission light**

QC-3243 WAS $29.95 NOW $19.95 SAVE $10.00

$59.00 SAVE $30.00

1500VA/830W LINE INTERACTIVE UPS WITH LCD

A wide array of protective features and gives the user the ability to monitor the status of the UPS through the backlit LCD and the intelligent power management software (included). The unit protects against low/over voltage, surges, short circuits and power overloads. In the event of mains failure, the UPS will switch to its battery (10-30 minutes back-up depending on the load).

- Output power: 1500VA
- 3 mains socket connections
- Line interactive with AVR
- Size: 337(L) x 192(H) x 116(W)mm

MP-5206 WAS $369.00

Limited stock. Not available online

$249.00 SAVE $120.00

300MBPS WIRELESS-N ADSL2+ MODEM ROUTER WITH 4 PORTS

NEW

Features four 10/100Mbps LAN ports with 802.11n (300Mbps) wireless connectivity. A variety of connection methods to support most ISPs and a multitude of advanced features to ensure a smooth web experience.

- PPPoE, PPPoA, IPoA and bridging connection modes
- Provides up to 24Mbps downstream rate and 1.4Mbps upstream rate (speed dependant on user distance from local exchange)

YN-8318

$99.95

WI-FI REMOTE WIRELESS IP CAMERA

The smallest IP camera we've ever seen! With its wireless network interface, the Ai-Ball allows you to stream and record audio video images over your network or directly to your Smartphone (iPhones® or Android devices) and laptop on the go. Powered by a CR2 battery and coupled with an incredibly compact design means you can easily carry the Ai-Ball around and even put it on your keychain!

NEW

- 640 x 480 resolution
- Size: 30(Dia.)mm

QC-3368

Ai-Ball cradle + adaptors available separately

QC-3369 $29.95

$99.95

USB BUSINESS CARD SCANNER

Save your business card contacts directly to an Outlook/Outlook Express address book. Using optical character recognition, it extracts text from the business card and categorise it in to 13 different fields.

- Scans single or double sided business cards
- Supports multiple languages
- Size: 120(L) x 70(W) x 20(D)mm

XC-4908 WAS $79.95

Laptop not included

$69.95 SAVE $10.00

HIGH AUDIO RESOLUTION DIGITAL STEREO RECORDER

A brilliant little recorder that lets you record your musical ideas quickly and easily or capture your next jam session. Simple one button recording - press once for standby then again to record, or use the VOX function to record to an SD card. Switchable stereo or mono. Requires 2 x AA batteries.

- Pocket size
- Line in and mic inputs
- Headphone and built in speakers
- Formats: MP3, WAV
- Size: 60(W) x 112(H) x 22(D)mm

XC-0386 WAS $199.00

$179.00 SAVE $20.00

ACCESSORIES TO SUIT APPLE® DEVICES

NEW

USB Charge/Sync Lead

USB charge/sync lead suitable for Apple® iPhone®, iPod® and iPad®.

- Length: 1m

WC-7693

$7.95

AV Component Lead

NEW

Connect an Apple® device to a HDTV, projector or home theatre system via the component RCA input. Features USB connection to charge the Apple® device. See online for compatibility.

- Cable length: 1.5m

WC-7699

$44.95 iPhone® not included

AV Docking Station for iPhone®/iPod®

Share and play music, pictures and videos on your TV, monitor or home audio system from your iPod® or iPhone®. Includes dock, full function IR remote control, AV and USB power cables.

- Composite video and stereo audio output
- USB charge port to keep your device powered
- Size: 88(W) x 74(L) x 19(H)mm

NEW

iPhone® not included

WC-7715

NEW **HDMI Docking Station for iPad®/iPhone®/iPod® with Remote also available**

WC-7717 $89.95

HDMI AV Cable for iPad®/iPhone®/iTouch®

Extend your multimedia capabilities with your Apple® devices. Share audio and video via HDMI connection on your TV screen, projector or even your home theatre audio setup.

- Cable length: 1.8m
- Support movies and photo slideshows
- Video resolution up to 1080p
- Compatible with iPad®1 & 2, iPhone®4/S, iTouch® 4th Gen

NEW

WC-7711

iPhone® not included

HDMI Converter for iPad®/iPhone®/iTouch® also available **WC-7713** $64.95

$69.95

10W MEGAPHONE WITH SHOULDER STRAP

Ideal for your next sports carnival, this 10W megaphone produces clear effective voice amplification to help start the race! Made from tough durable plastic, it works effectively up to 8 distance of 543m.

- Requires 6 x C batteries
- Size: 350(L) x 200(Dia.)mm

AM-4058 WAS $99.00

$89.00

SAVE $10.00

5.8GHZ HDMI SENDER WITH REMOTE EXTENDER

Watch Pay TV with full-HD quality in a second location without the monthly fee. Simply connect the transmitter to the HDMI source and the receiver into an HDMI equipped TV in the remote location.

- Up to 1080p/60Hz video resolution (Full HD)
- Size: 180(L) x 140(W) x 39(H)mm

AR-1875 WAS $379.00

$349.00

SAVE $30.00

SATELLITE FINDER

Find satellites fast with this excellent device. It will save hours of frustration when aiming your dish and is a must for portable systems such as RVs etc.

LS-3300

WAS $34.95

$24.95

SAVE $10.00

SLIMLINE LCD/PLASMA BRACKETS

Projecting only 10mm from the wall and very easy to install, they will accommodate an LED, LCD or plasma TV up to 80kg. The spring-loaded cleats lock in position so the TV can't be accidentally knocked off. Two sizes available for 23-37" TVs or 32-60" TVs.

- Fits standard spacing wall studs
- Ultra-low profile

From **$29.95**

SAVE $10.00

23 - 37", 45kg CW-2821
WAS $39.95 NOW $29.95 SAVE $10.00

32 - 60", 80kg CW-2823
WAS $49.95 NOW $39.95 SAVE $10.00

UNIVERSAL STEREO PREAMPLIFIER

Based around the low noise LM833 dual op-amp IC, this preamp is designed for use with a magnetic cartridge, cassette deck or dynamic microphone. It features RIAA/IEC equalisation, and is supplied with all components to build either the phono, tape or microphone version. Measuring only 80x78x30mm, it is ideal for incorporating into existing equipment and is hence supplied short form of PCB and specified components plus PCB standoffs for mounting.

- +/- 15VDC required
- Use **KC-5038** $14.95 and **MM-2007** $8.95 if power is not available in your equipment.

KC-5159

$16.95

TV HEARING AID EARPHONES

A lightweight TV hearing aid with comfortable ear inserts. It uses noise cancelling technology to reduce background interference and features voice clarification technology so you don't miss any dialogue in your favourite TV show, news broadcast or movie. A tone control button allows adjustment for different frequency hearing abilities and can be connected either directly to the TV or a digital set-top box. When not in use the cradle charges the batteries.

- Auto power off function for transmitter
- Multi user listening from receiver
- 12 hour battery life between recharges
- Headphone size: 195(H) x 138(W)mm
- Base size: 120(W) x 97(L) x 18(H)mm

AA-2079

$129.00

NEW

DJ SINGLE HEADPHONE WITH HANDLE

Closed back, single cup headphone, designed especially for DJs. Keeps one hand available and frees you up from the constraints of wearing headphones. Curly cord cable terminates to 6.5mm plug.

- Driver diameter: 50mm
- Impedance: 48 ohms
- Sensitivity: 98±3dB
- Frequency response: 15Hz - 20kHz

AA-2059 WAS $69.95

$29.95

SAVE $40.00

Limited stock. Not available online.

USB NXT SOUNDBAR SPEAKERS

Conveniently powered by USB, these plug-and play speakers dramatically outperform inbuilt notebook speakers. Being USB, they eliminate hard disk noise that all other non-USB speakers suffer from.

- Size: 220(L) x 70(H) x 45(D)mm

XC-5199 WAS $49.95

Laptop not included

$14.95

SAVE $35.00

Limited stock. Not available online.

SPLIT & CONVERT

Analogue to Digital Audio Converter

Convert a stereo analogue audio signal to coaxial and Toslink outputs simultaneously. Supports uncompressed 2-channel LPCM (Linear Pulse Code Modulation) digital audio signal output with sampling rate at 48kHz.

- Audio delay (150 min-seconds)
- Noise free transmission
- 5VDC power adaptor included
- Size: 67(W) x 50(D) x 23(H)mm

AC-1611 WAS $79.95

$49.95

SAVE $30.00

Toslink Digital Optical 2-Way Splitter

A digital optical 1-to-2 distributor featuring one Toslink input to two Toslink outputs. Mains power adaptor included.

- Power Supply: 5VDC 500mA
- Size: 46(L) x 46(W) x 24(H)mm

AC-1613 WAS $69.95

$59.95

SAVE $10.00

Tools

ABS INSTRUMENT CASE WITH PURGE VALVE

This robust case comes with purge valves for an airtight seal, ribbed ABS construction, stainless steel hinge pins, O-ring seals and very solid catches. Tiny size for small instruments or test equipment.

$39.95

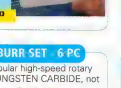
NEW

- Internal: 185(W) x 120(D) x 75(H)mm
- External: 210(W) x 165(D) x 90(H)mm

HB-6388

FRESNEL MAGNIFYING LENS WITH LED

Uses tiny circular prisms to create a thin, lightweight magnifier. Battery included.



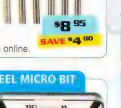
- Size: 80(L) x 50(W)mm

QM-3533
WAS $5.95

$3.95
SAVE $2.00

TUNGSTEN CARBIDE BURR SET - 6 PC

A set of six of the most popular high-speed rotary tool bits. Note these are TUNGSTEN CARBIDE, not cheaper HSS. 3mm shank size to fit most rotary tools or flexible shafts. Suitable for head porting, carving, modelmaking, hobby engineering, craft etc.



- Storage case: 90(L) x 60(W) x 25(H)mm

TD-2162 WAS $12.95

$8.95
SAVE $4.00

Limited stock. Not available online.

21-PCE STAINLESS STEEL MICRO BIT SET WITH DRIVER

Repair watches, sunglasses, and other objects that use tiny screws. Driver included.

Kit contains:

- Hex: 0.7, 0.9, 1.3, 1.5, 2
- Posidrive: 000, 00, 0
- Torx: T6, T7, T8, T9, T10, T15
- Philips: 000, 00, 0
- Flat blade: 0.8, 1.5, 2

TD-2110 WAS $29.95

$19.95
SAVE $10.00

G-FORCE METER KIT

Measure the g-forces on your vehicle and it's occupants during your next lap around the race circuit, or use this kit to encourage smoother driving to save petrol and reduce wear & tear. Forces (+/- 2g) are displayed on the 4-digit LED display. Also use it to measure g-forces on a boat crashing over waves or on a theme park thrill ride. Kit includes PCB with pre-mounted SMD component, pre-programmed microcontroller and all onboard electronic components.

- Requires 2 x AA batteries
- PCB: 100(L) x 44(W)mm

Note: We supply the PCB with the SMD component already mounted on the board to save time and frustration.

KC-5504

$49.95

RATCHET DRIVER WITH 9 BITS RIGHT ANGLE RATCHET DRIVER WITH 3 BITS

Get into hard-to-reach spots with this handy right-angle ratchet driver. It comes with 9 bits, and can take any standard 1/4" hex driver bit. Bits included are 4.5 & 7mm slotted, P1 & P2 Phillips, PZ1 and PZ2 Posidriv and T15 and T20 Torx.

- One-handed operation
- Size: 100(L) x 14(W)mmA handy right-angle ratchet driver for hard-to-reach place. It comes with 9 bits, and can take any standard 1/4" hex driver bit.

TD-2013 WAS $9.95

$6.95
SAVE $3.00

PRECISION SCREWDRIVER SET

Set includes 6 screwdrivers (3 Flathead and 3 Phillips). Ideal for working with computers, TVs, VCRs, radios etc. Supplied with a wall or stand bracket.

- Chrome vanadium steel

TD-2017 WAS $13.95

$9.95
SAVE $4.00

FLAMELESS GAS HOT AIR BLOWER

A handy little unit for blowing hot air without the presence of a flame. Uses butane gas and has Piezo ignition. Great for general heating and drying, reducing heatshrink tubing and working with plastics etc.

- Refill with butane gas (NA1020)
- Size: 148(L) x 35(W) x 23(D)mm

TH-1602 WAS $29.95

$19.95
SAVE $10.00

5W USB SOLDERING IRON

You wouldn't think USB could supply enough power for a usable soldering iron, but it works by using two USB ports and produces enough heat to be a viable service tool.

- Pocket-sized
- Power: 4 - 5W
- Size: 120(L)mm

TS-1537 WAS $29.95

$19.95
SAVE $10.00

ADJUSTABLE HOLESAW

An excellent cutter designed to cut plaster board and ceiling tiles. Features calibrated hole size adjustment.

From $36.95
SAVE $33.00

62 to 177mm hole size TD-2520 WAS $69.95 NOW $36.95 SAVE $33.00

158 to 264mm hole size TD-2522 WAS $79.95 NOW $44.95 SAVE $35.00

WATER-Ddisplacement & LUBE SPRAY

Specially formulated for use with electronic and mechanical assemblies.

- 175g

NA-1025 WAS $5.95

$3.95
SAVE $2.00

9 PIECE FOLDING TORX KEY SET

Handy folding sets of Torx or Allen keys with sturdy anodised aluminium handles. The handles have M8, M10, E8 and E10 spanners built into them.

Torx Key Set: T5, T6, T7, T8, T9, T10, T15, T20, T25

TD-2170 $5.95

Ball Allen Key Set Metric: 1.5, 2, 2.5, 3, 4, 5, 6

TD-2172 $5.95

Ball Allen Key Set Imperial: 1/16", 5/64", 3/32", 1/8", 5/32", 3/16", 7/32"

TD-2174 $5.95

$5.95 Ea

Buy 3 for $10 SAVE $7.85

CABLE STAPLE GUN

Take the pain out of cable installation. Simply staple the cable to eaves, rafters or joists. The staples have an integral plastic cable clamp that holds the cable firmly in place.

FREE Staple refills choose from (TH-2616 & TH-2618) valued at $6.95

- Includes heavy duty die cast gun, 3 interchangeable blades and 200 staples in a carry case

TH-2615 WAS $49.95

$39.95
SAVE $10.00

METERS

Multifunction Water Quality Meter

Tests pH, temperature, total dissolved solids (TDS), electrical conductivity (EC), conductivity factor (CF) and oxidation reduction potential (ORP). The backlit LCD can display pH plus one other parameter at a time. 9VDC mains adaptor, charger, buffer solution, probes with holder and carry case included.

- Temperature: 0 - 100°C ±0.4%
- Power: Built in 9V 200mAh rechargeable battery (charger included)
- Size: 208(W) x 200(H) x 76(D)mm

QM-1675 WAS $449.00

$299.00
SAVE $150.00

Limited stock. Not available online.

FREE Buffer refill choose from (QM-1672 or QM-1673) valued at $2.95

Sound Level Datalogger

Designed for recording and logging sound pressure level measurements for quality control, illness prevention, acoustic design or any other type of environmental sound measurement in domestic or industrial applications. Battery and windsock included.

- USB interface
- Over-range indication
- System requirements: Windows 2000, XP, Vista
- Size: 140(L) x 28(W) x 21(H)mm

QM-1599 WAS $149.00

$109.00
SAVE $40.00

All Savings are based on Original RRP. Limited stock on sale items.

Pre-Catalogue Sale

2.4GHZ DIGITAL WIRELESS MINI DVR KITS

These mini DVR systems operate on the 2.4GHz DIGITAL band which means stable, interference free transmissions. No cabling means easy set up. Great for a wide range of applications at home, small retail shop or office. Two models are avaiable, both include one colour outdoor day/night camera with motion sensor, a ball & socket mounting bracket, and utilise channel hopping to prevent interference. Both have easy to navigate system settings, manual recording, schedule recording or record with motion detection. Both use SD cards (not included) to store video and playback is via the SD card to a PC.
See website for more info.

2.4GHz Digital Wireless Receiver with Camera QC-3630 $249.00

2.4GHz Digital Wireless Display/ Receiver with Camera and Integrated 7" LCD QC-3632 $349.00

$199.00 SAVE $50.00

$279.00 SAVE $70.00

PAN/TILT/ZOOM CHILD MONITOR /GENERAL SURVEILLANCE SYSTEM

Keep an eye on a room full of children and pan across to zoom onto any one of them, or monitor swimming pool, retail showroom, or factory. You can remotely pan or tilt the camera or even zoom in for a closer look.

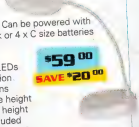
- 2.4GHz DIGITAL Wireless transmission
- 100m transmission range
- 2.4" LCD monitor screen
- CMOS image sensor (640 x 480 pixels)
- Camera pans 270°, tilts 120°
- 2 times digital zoom
- 4 separate channels
- Includes power adaptor for both units
- Size: Camera: 112(W) x 109(D) x 133(H)mm
  Monitor: 68(W) x 26(D) x 149(L)mm

QC-3638 WAS $299.00

$279.00 SAVE $20.00

LED LABORATORY MAGNIFIER LAMP

Includes an extension pole that transforms it from a desk top unit into a floor standing unit, as well as detachable desk-mounting clamp. Can be powered with the provided plug pack or 4 x C size batteries (avaiiable separately).



- 20 high-brightness LEDs
- 4 dioptre magnification
- 127mm diameter lens
- 1200mm floor mode height
- 800mm desk mode height
- Mains plugpack included
- Base size: 310(L) x 230(W)mm

QM-3542 WAS $79.00

$59.00 SAVE $20.00

DMX CONTROLLED LED SPOTLIGHTS

Each unit features bright red, green and blue LEDs, which can produce a wide range of colour effects. Powered by 240VAC, individually addressable via DIP switch and equipped with up to 5 channels of DMX controls. Mounting bracket included.

61 LED 4 Channel
- Robust ABS housing
- Size: 180(L) x 170(Dia.)mm

SL-3420
WAS $99.00

$79.00 SAVE $20.00

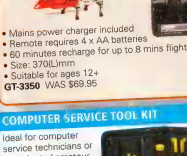
94 LED 5 Channel
- All aluminium construction
- Size: 300(L) x 135(Dia.)mm

SL-3422
WAS $139.00

$119.00 SAVE $20.00

3CH 27MHZ RC HELICOPTER

All aluminium airframe chopper complete with a built-in gyroscope which provides a very stable flight. The dual blade design enables easy control; perfect for beginners and intermediate flyers. Comes with a lightweight rechargeable Li-Po battery.



- Mains power charger included
- Remote requires 4 x AA batteries
- 60 minutes recharge for up to 8 mins flight time
- Size: 370(L)mm
- Suitable for ages 12+

GT-3350 WAS $69.95

$59.95 SAVE $10.00

ABS PLASTIC RACK MOUNT CASES

The cases are made of strong ABS plastic and supplied in a knock-down form that can be assembled in seconds with just a screwdriver. Slots are moulded into the top and bottom covers to provide good cross-flow ventilation while moulded PCB standoffs allow printed circuit boards to be mounted directly onto the covers.

- Biege in colour

1 Unit HB-5135 WAS $44.95 NOW $34.95 SAVE $10
2 Unit HB-5145 WAS $59.95 NOW $44.95 SAVE $15
3 Unit HB-5160 WAS $69.95 NOW $59.95 SAVE $10

From **$34.95** SAVE $10.00

RED TWINKLE DMX LASER SHOW

Whether staging a dance club or house party, this laser light projector helps create the perfect dance floor atmosphere. Produces truly spectacular lighting effects with plenty of geometric patterns and overall effects to choose from.

- Size: 205(L) x 80(W) x 145(H) mm

SL-3431
WAS $149.00

$119.00 SAVE $30.00

COMPUTER SERVICE TOOL KIT

Ideal for computer service technicians or the talented amateur. See website for full contents.

- Black zipper case
- Case size: 220(H) x 155(W) x 38(D)mm

TD-2040
WAS $29.95

$19.95 SAVE $10.00

HELICOPTER SPY CAMERA

Designed to mount on large model helicopters, planes, cars. 4GB internal memory gives about 4 hours of video.

- Shockproof construction
- Ball swivel lens
- 90 degree viewing, 60 degree rotation
- Mini USB video transfer and charging
- Mounting bracket included
- Size: 80(L) x 19(Dia.)mm

QC-3820 WAS $99.00

$59.00 SAVE $40.00

GREEN LASER STAR PROJECTOR

Projects thousands of dazzling green laser star like formations and comes with an integrated amplified speaker to connect an iPod® and MP3s. To complete the ambience, it also has colour changing LEDs which can be set to beat with the music or one of the four colours (red, green, blue and white)

- Laser colour: green
- Laser power: <1mW
- Amplifier: 6WRMS
- Size: 140(L) x 140(H) x 110(D)mm

SL-2931 WAS $119.00

$79.00 SAVE $40.00

8 PORT PARALLEL SPEAKER HUB

Distribute output from your amplifier to up to eight pairs of speakers (stereo). Its lightweight compact chassis make it suitable for wall mounting. Screw terminals handle wire sizes 12-24 gauge.

- Size: 196(L) x 94(W) x 29.5(H)mm
- Weight: 246g

AC-1663 WAS $49.95

$24.95 SAVE $25.00

All Savings are based on Original RRP. Limited stock on sale items.

Jaycar Electronics
Better, More Technical

Outdoors

3 WATT 38 CHANNEL UHF CB RADIO WITH SCRAMBLER

With up to 10km transmission range, a maximum output of 3W, a 500mW battery saver mode, high gain (168mm) antenna fitted with SMA connector for an external antenna, this unit is ideal for those long distance bush walks or 4WD adventures.

- Scrambler & CTCSS
- UHF FM transmission
- No licence required
- ACMA approval

$129.00
SAVE $40.00

Accessories to suit available separately. See in-store or online for details
DC-1060 WAS $169.00

Limited stock. Not available online.

BREAKDOWN & EMERGENCY ROAD FLASHER

Every car on the road should have a couple of these. Simply switch them on and place them on the ground to warn other motorists and guide them around a problem.

- Requires 2 x AAA batteries (use SB1739 $10.95)
- Size: 90(Dia.) x 25(H)mm

ST-3185

$9.95

Buy 2 for $15.00 SAVE $4.90

Limited stock. Not available online.

SOLAR RECHARGEABLE KEYHOLE LIGHT

Simply push it to turn the LED light on, then it stays on for 15 seconds before turning off automatically. Ideal for sheds, greenhouses or entrance doors.

- Automatically recharges from sunlight
- Size: 50(Dia.) x 22(H)mm

GH-1832 WAS $9.95

$3.95
SAVE $6.00

Limited stock.
Not available online.

TORCH & CHARGER DEAL!

190 Lumen CREE® LED Powered Torch

This chunky little torch features a powerful CREE® LED that will blast out 190 lumens of white light on the maximum setting. Multiple light modes are available for any situation.

- Requires 1 x CR123A Li-ion battery

ST-3450

$24.95

BUY BOTH FOR $45 SAVE $9.90

Lithium-Ion CR123A Battery & Chargers

CR123A batteries are commonly used in some LED torches and many cameras. Now there's a rechargeable option. The intelligent design will fully recharge the included battery in about 3 hours with LED charge status indicator.

Includes battery
Size: 90(L) x 40(W) x 25(H)mm
B-3581

$29.95

3W LED TORCH WITH SOLAR CHARGING COMPARTMENT

The torch slides into the compartment and is charged with the amorphous solar panel giving you fairly self sufficient little unit. Great for camping and long trips away from mains power.

- Lumens: 150
- 2.5 hours burn time
- Water resistant torch

ST-3469 WAS $69.95

$49.95
SAVE $20.00

MAGNETIC WORK LIGHT - RECHARGEABLE

With 61 super bright LEDs, it provides enough light for any situation. Equipped with two powerful magnetic clip-on brackets for fixing metal surfaces, leaving your hands free. Recharged via mains or a car cigarette lighter outlet (both included).

- Water, oil and shock resistant
- Recharging time: 3 hrs

ST-3021 WAS $49.95

$34.95
SAVE $15.00

OUTDOOR FLAT PANEL UHF/VHF AMPLIFIED DIGITAL ANTENNA

Easily adjust vertical and tilt position to maximise reception strength once mounted. With an integrated amplifier, it delivers local free-to-air analogue and digital TV as well as DAB+ digital radio programs. Includes mounting bracket, 6V 100mA mains adaptor, and PAL to F coaxial cable.

- VHF Band III 174-230MHz
- UHF Band IV & V 470-862MHz
- Impedance: 75ohms
- Panel size: 281(W) x 305(H) x 20(D)mm

LT-3139 WAS $69.95

$49.95
SAVE $20.00

SOLAR POWERED LED SPOTLIGHT

Ideal for outdoor lighting. The spotlight utilises 30 super bright LEDs and a weather resistant polycrystalline solar panel to keep the internal SLA battery fully charged quickly and ready for use. When darkness falls, the spotlight will turn on automatically and burn for around ten hours on a full charge.

- Lead length: 3m approx.
- Lamp size: 145(W) x 95(H) x 70(D)mm
- Solar panel size: 340(W) x 180(H) x 30(D)mm

SL-2716 WAS $149.00

$79.00
SAVE $70.00

ECLIPSE AAA SIZE LED KEYRING TORCH

Throws out enough light to find your keys or avoid tripping over the cat.

- Keyring lanyard included

ST-3383
WAS $4.50

$2.50
SAVE $2.00

2KW SINE WAVE INVERTER GENERATOR

Petrol powered and differs from cheaper units. The engine which is built to the same design as the market leading Japanese brands, drives a DC alternator. The inverter then converts the DC to a stable pure sine 230VAC, suitable for appliances including sensitive electronics. No matter what the load is on the generator, the output remains at 230VAC 50Hz. Compact, the petrol motor keeps engine speed in line with the load, reducing noise and increasing fuel efficiency.

- Electric start & recoil start
- 7L fuel capacity (approx 6.5hr run time)
- 2 x 230/240V GPO power outlets
- 12V 8.3A vehicle battery charger output
- LED indicators for output, overload and oil level

MG-4000

NOTE: Not available in all stores but can be ordered. Call your nearest store or check online for details.

$899.00

LED INDICATOR STRAP FOR CYCLISTS

Strap this LED indicator to your back and control your left and right turn signals with a wireless controller. The LED strap uses 28 powerful LEDs that will be easily visible in the dark or in low light/foggy environments.

- Requires 3 x AAA batteries

ST-3226 WAS $29.95

$19.95
SAVE $10.00

90W MONOCRYSTALLINE SOLAR PANEL

NEW

Here is an addition to our Powertech Mono-crystalline solar panels which offer you the same robust construction and performance as the leading brand names, whilst also offering a nice cost saving against the big brands. Built and suited to withstand harsh Australian conditions. Covered by a 25 year warranty. See our website for full range and specifications.

- Maximum power: 90W
- Rated voltage: 12V
- Weight: 8.2kg
- Size: 1200 x 540 x 35mm

ZM-9086

$325.00

SOLAR LED SPOTLIGHT KIT

Add a light to the garden shed, carport, entrance door or even for a wandering pet. The 135 x 87mm solar panel mounts anywhere you can catch some rays and the 9 LED spotlight can be mounted wherever it's needed.

- 3 x AA rechargeable batteries included
- Cable length 3m

SL-2752 WAS $39.95

$29.95
SAVE $10.00

All Savings are based on Original RRP. Limited stock on sale items.

WIRELESS REVERSING CAMERAS & LCD MONITOR KIT

Parking your car with trailer or caravan could not be easier with these reversing cameras. Each camera transmits wirelessly to the 3.5" colour monitor which mounts to the windcreen using a suction cup and plugs into the cigarette lighter socket for power. The 2.4GHz transmission provides a range of up to 80m making it suitable for a wide range of vehicle and trailer combinations including very large motor homes, trucks and caravans.

- Includes two colour cameras
- 12VDC operation
- Screen size: 110(W) x 77(H) x 22(D)mm

QM-3797 **$249.00**

500WRMS LINKABLE CLASS D SUBWOOFER AMPLIFIER

With a massive 500WRMS @ 1ohm power output, this low profile pint-sized monoblock amp will push your subwoofers to their limits, yet will do so with greater efficiency and far less heat than class AB amps. Plus you get variable bass boost, adjustable phase shift, low pass & subsonic filter and master/slave operation. See online for full specification.

- Size: 232(L) x 178(W) x 59(D)mm

AA-0454 WAS $199.00 **$179.00** SAVE $20.00

See instore or check online for full range of car amplifiers.

DC TO DC CONVERTER

Charge your mobile phone, iPod®, camera or other USB devices via your vehicle's cigarette lighter socket.

- Size: 68 (H) x 56(W) x 52.5(D)mm

MP-3042 WAS $9.95 **$5.95** SAVE $4.00

Limited stock. Not available online.

TWIN PORT SUBWOOFER ENCLOSURES

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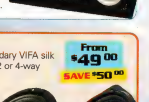

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CS-2395 WAS $129.00 NOW $64.00 SAVE $65.00
6 x 9" 150WRMS 4 Way Car Speakers
CS-2397 WAS $189.00 NOW $94.00 SAVE $95.00

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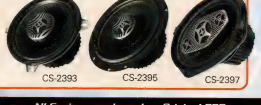


CS-2393 CS-2395 CS-2397

CAR VIDEO EVENT RECORDER

Capture the accident and playback later. This handy device is automatically activated by the built-in 3-axis G sensor that responds to a sudden braking or a collision. It records the event to an SD card (16GB stores up to 5hrs - card not included). Also records car speed and GPS location.

- 120° wide-angle camera with IR LEDs
- Supports SD cards
- Video resolution: 640 x 480 @ 30 fps
- Real time clock stamp
- Video output for external monitor
- Size: 92(W) x 80(H)mm

QV-3798 WAS $249.00 **$199.00** SAVE $50.00

7" TOUCH SCREEN LCD MONITOR WITH USB

Touch screen capabilities enables use with a laptop/PC, games console and endless other VGA operating devices. Use it to control a computer or any other USB compatible device. The monitor can be mounted either on the bracket or flush mounted with cradle. Software and adaptor cables included.

- Size: 178(W) x 122(H) x 30(D)mm

QM-3744 WAS $199.00 **$189.00** SAVE $10.00

12V 3.5" LCD MONITOR

This monitor perfectly mounts onto your vehicles dashboard. The rear vision view is automatically activated when the reversing gear is engaged. Includes adjustable swivel bracket and sunshade.

- Two composite video inputs
- Automatic mirror image selector for reversing cameras
- Powered by 12VDC
- Size: 100(W) x 87(H) x 25(D)mm

QM-3792 WAS $79.00 **$59.00** SAVE $20.00

WIRELESS DIGITAL VEHICLE PARKING ASSIST SYSTEM

This 4 sensor reversing system utilises a wireless connectivity between the monitor and the sensors of up to 30 metres making it suitable for larger vehicle installations such as trucks, buses, motor homes, caravans, etc. Distances from objects are accurately displayed on the 5 colour LCD display as well as voice and beep alerts.

- Power: 12VDC
- Display size: 72(L) x 53(W) x 17(D)mm

Sensor size: 23(L) x 21(Dia.)mm

LR-8874 WAS $129.00 **$99.00** SAVE $30.00

REVERSING CAMERA AND MONITOR DEAL!

3.5" LCD Car Dash-Mount Colour Monitor

The reversing camera monitor mounts perfectly on your vehicles dashboard and when not needed, folds down into a compact shell for dust-protected storage. With two video inputs, the rear vision view is automatically activated when your reversing gear is engaged (use QC-3513 camera below).

- Crisp high resolution display
- TFT active matrix system
- Auto switching PAL (4.43MHz) and NTSC (3.58MHz)
- Power: 12VDC 8W

QM-3771 **$89.00**

Flush Mount Mini Waterproof Camera for Cars or Trucks

Buy both for $140.00 SAVE $38.95

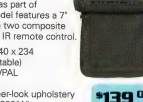
Designed for use in vehicles to give drivers a clear view of car or truck blind spots. A lengthy 5m composite RCA cable, a 730mm power cable, and the appropriate sized hole saw are included.

- Sensor: CMOS
- Resolution: 628 x 512 pixels
- Camera size: 31(L) x 20(Dia.)mm

QC-3513 **$89.95**

7" TFT COLOUR MONITOR WITH HEADREST

If you already have a DVD player or other video source in the car, you can set this up as a second or third monitor as part of system. This model features a 7" TFT screen, with two composite video inputs and IR remote control.



- Resolution: 1440 x 234 (16:9/4:3 selectable)
- System: NTSC/PAL
- Power: 12VDC
- Dark grey leather-look upholstery
- Headrest size: 280(W) x 200(H) x 110(D)mm

QM-3766 WAS $189.00 **$139.00** SAVE $50.00

Security

TIME LAPSE HD VIDEO CAMERA WITH LCD VIEWFINDER

Create amazing time lapse videos in high definition. Frame the subject using the LCD viewfinder and 120 degree rotatable lens, set the time interval between 1 sec to 24 hours, then start capturing. The video created on the included 2GB SD card can be played back on a computer, media player or suitable TV. Power by 4 x AA batteries (included) or from the USB port of a computer (USB cable required).

- 1280 x 720 resolution
- Size: 106(H) x 64(W) x 46(D)mm

QC-8034

NEW

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View demo videos on our website

Weatherproof Time Lapse Camera also available **QC-8030** $199.00

WIRELESS COLOUR VIDEO DOORPHONE

A compact wireless video doorphone that's full on features. Incorporating digital encryption and code-hopping 2.4GHz wireless transmission, signals are clear and interference-free up to 100m range. The receiver unit features 3.5" TFT LCD, stores up to 200 images and is built in rechargeable battery. The camera unit is equipped with a wide angle lens IR illumination and is easy to install.

- Clear night vision
- Mini USB for PC interface
- Rechargeable lithium battery
- Size: 290(W) x 210(H) x 50(D)mm

QC-3253 WAS $299.00

$249.00

SAVE $50.00

Spare battery to suit also available **QC-3554** WAS $19.95 NOW $14.95 SAVE $5.00

ROLLING CODE INFRARED KEYLESS ENTRY SYSTEM

Refer Silicon Chip Magazine October 2007

This keyless entry system features two independent door strike outputs and will recognise up to 16 separate key fobs. The system keeps the coded key fobs synchronised to the receiver and compensates for random button presses while the fobs are out of range. Supplied with solder masked and silk screen printed PCB, two programmed micros, battery and all electronic components.

- Receiver requires a 12VDC 1.5A power supply
- Some SMD soldering is required
- PCB: 61 x 122mm

KC-5458

$64.95

WIRELESS PIR ANNOUNCER

Monitor areas wirelessly with this PIR motion detector. The main control panel is alerted when movement is detected and triggers a signal. Ideal for retail stores, offices or work shops. Easy to install and simple use.

- Detection range 4 - 5m
- Size: Unit: 122(W) x 143(H) x 52(D)mm Wireless PIR: 75(W) x 120(H) x 60(D)mm

LA-5172

$59.95

NEW

Also available: **Wireless Solar PIR Announcer LA-5174** $79.95

FOUR INPUT IP VIDEO SERVER WITH SOUND

This 4 input video capture unit can be given a fixed IP address which allows all four video inputs to be viewed via an web browser from anywhere in the world. Features a four input video capture card with motion detection, single audio input, an Ethernet connection, and a Linux based web server. Once the unit is configured, it can operate without a computer and can broadcast to the world.

- 640 x 480 resolution
- Email alert capability
- JPEG video capture up to 25 fps
- Embedded Web Server
- FTP of captured images
- Supports IP, HDCP, or PPoE

QC-3393 WAS $249.00

$199.00

SAVE $50.00

WIRELESS DOORBELL WITH LCD CLOCK & TEMPERATURE

This wireless doorbell unit comes with 32 melodies and integrates an indoor and outdoor temperature display plus an alarm clock function. The waterproof doorbell transmitter has a name plate feature and is easy to install with no messy wiring required. It has an operating range of 100 metres.

$24.95

SAVE $5.00

- Receiver requires 2 x AA batteries
- Transmitter requires 2 x AAA batteries
- Receiver size: 115(W) x 88(H) x 35(D)mm
- Transmitter size: 35(W) x 89(H) x 28(D)mm

LA-5001 WAS $29.95

USB MINI INSPECTION CAMERA

Use a laptop as a monitor to check for termites and other rodents, finding lost tools etc. Features a 10mm diameter, two variable intensity LEDs for illumination, and an extra long cable for access in tight spaces.

- Mirror and magnet pick-up tool included
- USB powered
- 7m long cable
- Size: 10(Dia.) x 520(L)mm

QC-3371

NEW

$59.95

2.4GHZ BABY MONITOR SYSTEM WITH PORTABLE LCD & NIGHT VISION

Monitor your baby sleeping or your kids at play in the backyard. Features a portable 2.4" colour LCD and CMOS colour camera with inbuilt mic. The 2.4GHz digital transmission ensures a stable, clear and interference free picture up to 100m away. The camera unit features infrared night vision and voice activation mode to keep you alert throughout the night.

$139.00

SAVE $30.00

- Rechargeable Li-ion battery and charging cradle for monitor included
- 4 channel operation

QC-3251 WAS $169.00

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CIRCUIT NOTEBOOK

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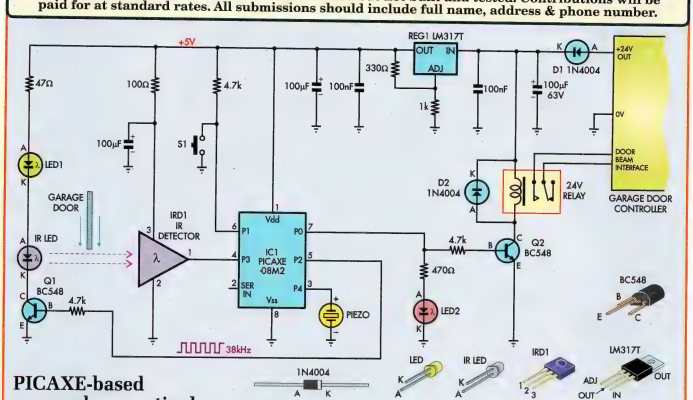

PICAXE-based garage door sentinel

Many garage door controllers have an infrared beam to detect people or objects in the path of the door, preventing it from closing on them. This can be handy to prevent injury and property damage. The simple circuit shown here does the trick.

The garage door controller generally has a 24V DC output. REG1 generates a +5V rail from the incoming 24V and this powers an infrared LED. LED1 is a standard green LED connected in series, which indicates that the unit is active. Both LEDs are pulsed at 38kHz by NPN transistor Q1 which is driven from output P2 (pin 5) of IC1, a PICAXE08M2 microcontroller.

The modulation prevents other IR sources (eg, the sun or an incandescent lamp) from interfering with the circuit. A 47Ω resistor limits the current through LED1 and the infrared LED to around 40mA peak. The duty cycle is 50% so the average LED current is around 20mA.

IRD1 is a standard infrared remote control receiver and is placed on the opposite side of the garage door from the IR LED. It has internal circuitry to ignore any infrared signals without 38kHz modulation. Microcontroller IC1 senses its output level at input P3 (pin 4), which goes high when the beam is broken, triggering a software interrupt.

IC1 drives its output P0 (pin 7) high while the beam is not broken, ie, input P3 is low. This illuminates red LED2 and also turns on NPN transistor Q2, energising the 24V relay which signals to the garage door controller that it's OK to close the door.

Should the beam be broken, after a short delay, pin 7 of IC1 goes low and the relay switches off, forcing the door to stay open. IC1 is programmed to ignore very short losses of signal to IRD1 as these may be caused by flying insects, electrical noise and so on. Diode D2 clamps the inductive spike from the relay coil when it switches off, while a 470Ω series resistor limits the current through LED2 to around 10mA.

IC1 also periodically drives the piezo buzzer connected to its P4 output (pin 3) if the beam is broken, resulting in a series of chirps. This helps you adjust the infrared LED/receiver alignment and provides an audible warning that the doorway is obstructed. If necessary, pushbutton S1 (connected to input P1, pin 6 of IC1) provides a manual override and pushing it allows the door to close within a 2-minute period, regardless of whether the beam is broken.

The infrared LED can be mounted in a small enclosure and linked to the main unit (on the other side of the garage) with 2-core cable. A small tube should be placed over IRD1 so that it doesn't respond to reflected IR light (or it can be mounted well inside an enclosure with a small hole in the side).

Both the transmitter and receiver should be mounted on or near the door roller guides, positioned so the beam is unobstructed when the door is fully closed. They should ideally be mounted low enough to detect children walking through the door. The unit can operate with doors up to 10m wide but requires careful alignment.

The software, "garage door.bas", is available for download from the SILICON CHIP website.

A. Doust,
Erskine, WA. ($50)

Improvements to the Milliohm Adaptor

The Milliohm Adaptor (SILICON CHIP, February 2010) has been popular but some constructors have reported inaccuracies at the lower end of its ranges. This is due to limitations of the AD623 rail-to-rail output instrumentation amplifier. For example, a resistor which measures exactly 1Ω on the 0-1Ω range may measure around 0.85Ω on the 10Ω range.

There is a relatively simple solution to this problem, giving much improved accuracy and precision for low values. The original and updated (Fig.1) circuits are shown here. In the original circuit, the reference voltage fed to pin 5 of IC3 (its output ground reference) is adjusted to somewhere between 0mV and 10mV using trimpot VR5. This allows its output offset to be nulled.

The problem is that, like all rail-to-rail output amplifiers, the AD623's output can't quite swing all the way to its supply rails. In this case, the negative rail is connected to ground and as the output voltage approaches 0V, the amplifier operates in a less linear fashion due to the lower output transistor going into saturation, resulting in an inaccurate reading. This error gets worse the closer the output gets to 0V.

According to the AD623 data sheet, the most linear portion of its output range is from 50mV above the negative rail (ground) up to 0.5V below the positive rail. To be safe, we increase IC3's reference voltage to about 500mV, so that its output will always be well within that range. By increasing the negative output terminal by the same amount, the attached DMM can still read down to zero.

In the modified circuit, the resistances in the bottom of the reference divider are increased to raise the reference voltage fed to pin 5 of IC3. This also increases the source impedance which would affect the instrumentation amplifier accuracy so the previously unused half of LM358 dual op amp IC2 buffers this voltage.

The negative output terminal potential is adjusted separately, using existing trimpot VR5, to allow any offset errors to be properly nulled, including those from IC2 and IC3 plus errors due to resistor tolerances.

Because the input impedance of the DMM is in parallel with part of the reference voltage divider, the current through it has been increased to minimise loading effects. This involves reducing the value of the 22kΩ resistor in the upper half of the divider to 10kΩ. The 6.2kΩ resistor limiting the current to the 2.49V reference diode has also been decreased to 4.7kΩ, to ensure that IC4 still has sufficient bias current.

With these changes, follow the set-up procedure as explained in the original article and then re-adjust the gain setting (VR4). This ensures that the gain is set correctly with the amplifier output zeroed.

Stuart Wattison is this month's winner of a $100 gift voucher from Hare & Forbes

The improved precision in low readings means that the Milliohm Adaptor is more useful for tasks such as finding short circuits in PCBs by looking for the points on the two tracks with the lowest resistance between them.

Higher test currents

For checking grounding straps, a higher test current is desirable. Ideally, it should be greater than the typical trip current of an earth leakage circuit breaker (30mA). A suitable current source is shown in Fig.2. This can run off six AA alkaline or NiMH cells.

The LM358 op amp monitors the voltage drop across the parallel combination of R1 and R2, the latter being in series with trimpot VR1. VR1 is adjusted so that the BD682's emitter resistance is very close to 24.9Ω and therefore the voltage across them at 100mA is 2.49V. The LM358 then drives the BD682 to maintain this level of current flow. Since it is a Darlington transistor, the base current is small and so the collector current is very close to the emitter current.

Two 1N4004 diodes allow the current source to operate normally even when the test resistance is not connected. These have no effect during normal measurements as the voltage between the force terminals is normally no more than 1V. Two series 2.2kΩ resistors protect the Milliohm Adaptor from the possibility of damage due to the higher force current.

The table in Fig.2 shows how the circuit can be adapted to provide 1A if necessary; note that a much larger heatsink (<3°C/W) will be required.

With a 100mA current source, the Milliohm Adaptor sense ranges become 0-1Ω and 0-0.1Ω. With a 1A current source, they become 0-0.1Ω and 0-0.01Ω. Keep in mind that with a 1A test current, the resulting voltage is 1V/Ω and so you can measure it with a normal DMM in volts mode.

Four-terminal sensing

Four-terminal sensing (ie, Kelvin connections) is important to accu-

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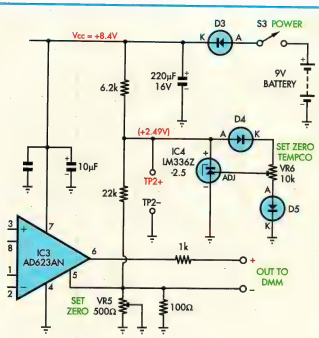


ORIGINAL CIRCUIT (FEB. 2010)

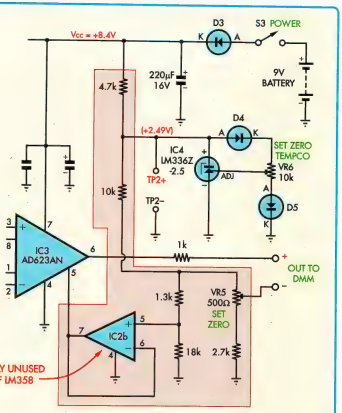
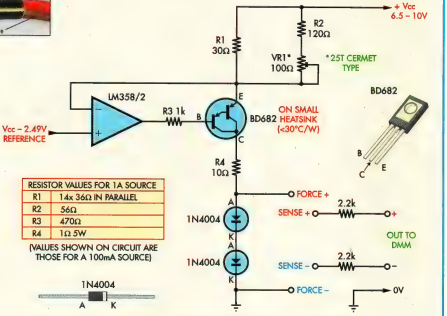


FIG.1: MODIFIED CIRCUIT

rately measure low resistances. This was explained in the original article but using four separate leads can be inconvenient. The photo shows a clip lead made up for this purpose which can be used just like any other clip lead. A short section of 2mm diameter tinned copper wire is glued into the upper portion of the alligator clip with a layer of insulation is between them so there is no electrical contact.

The sense wire is soldered to the tinned copper wire while the force wire is soldered to the alligator clip itself. Note that the tinned copper wire must protrude far enough so that it touches the lead of the device under test before the jaw does.

Stuart Wattison,
Athelstone, SA.



RESISTOR VALUES FOR 1A SOURCE	
R1	14x 36Ω IN PARALLEL
R2	56Ω
R3	470Ω
R4	1Ω 5W

(VALUES SHOWN ON CIRCUIT ARE THOSE FOR A 100mA SOURCE)

FIG.2: 100mA (OR 1A) TEST CURRENT SOURCE

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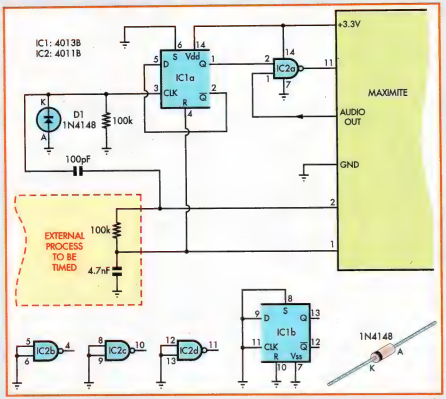


Measuring short intervals with the Maximite

It can be difficult to measure the duration of brief events with microcontrollers that run BASIC, such as the Maximite (SILICON CHIP, March-May 2011). For example, the Maximite's TIMER function has a resolution of one millisecond (1ms). A small amount of additional circuitry can be used to solve this problem.

There are a variety of applications where this is necessary, eg, ultrasonic range-finding. Because sound travels at roughly 300m/s, a Maximite-based range-finder with a 1ms resolution, can only work in steps of about 200mm, giving poor accuracy and repeatability.

The solution is to use the Maximite's audio output as a pulse generator and gate these pulses with the signal you want to measure. You then pass the resulting signal back to the Maximite which then counts the pulses it receives. In other words, the Maximite only receives these pulses during the time period that you are trying to measure. Its counter handles signals up to 200kHz, resulting in a measurement resolution of 5µs.

To allow the audio output to give a full-scale square wave compatible with digital logic, some changes to the Maximite are required. Specifically, the 5.6kΩ and 1kΩ resistors in the audio output voltage divider should be replaced with a wire link and a 6.8kΩ resistor respectively.

The sample circuit shown here measures how long it takes for a 4.7nF capacitor to charge to an arbitrary voltage threshold via a 100kΩ resistor. It can easily be adapted to other tasks.

IC2a is one section of a quad NAND gate (CD4011). The pulses from the audio output of the Maximite are fed to its pin 1 input. When the pin 2 input is high, its pin 3 output delivers the audio output pulses (inverted) to the Maximite. When the pin 2 input is low, its pin 3 output remains high and so no pulses pass through.

IC1a is half of a CD4013 dual D-type flipflop and this controls the gating signal at pin 2 of IC2a. Since its Q-bar output (pin 2) is connected to its data input (pin 5), its Q output (pin 1) will invert on the positive edge of each clock pulse on pin 3.

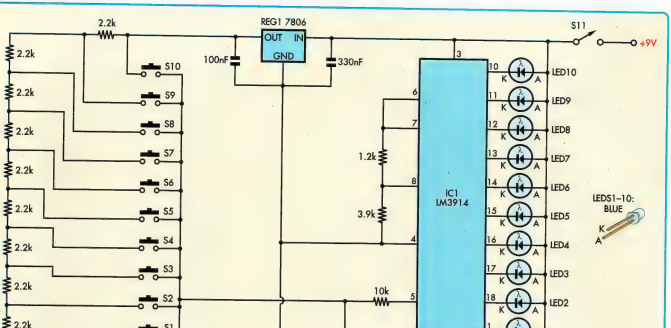
Assuming IC1a is initially in a reset state (ie, the Q output is low) and the Maximite's pin 2 output goes from low to high, the pulse coupled to its clock pin via the 100pF capacitor will set its Q output high. In this state, the Maximite's audio pulses are received at its pin 11 input. A high state on the reset pin (pin 4) will then bring the output low again, cutting off those pulses.

The 100kΩ resistor and 1N4148 diode (D1) at pin 3 of IC1a discharge the 100pF capacitor after each clock pulse is coupled and prevent that input from being pulled more than one diode drop below ground when the pin 2 output of the Maximite goes low again.

Now let's look at how the charge time of the 4.7nF capacitor is measured. Initially, it is discharged and IC1a is reset by the Maximite. The audio output is then configured to generate a 200kHz square wave and pin 11 is set up to measure the pulses. Also, pin 1 is set to trigger an interrupt on a low-to-high transition. Because IC1a has been reset, at

PROGRAM LISTING

```
10 SETPIN 1,8:PIN(1) = 1:PIN(1) = 0          ' reset 4013
20 SETPIN 2,8:PIN(2) = 0                     ' discharge cap
30 SETPIN 1,6,110                            ' pin 1 is I2h interrupt
40 SOUND 200000,5000                         ' 200kHz from audio output
60 SETPIN 11,5                               ' pin 11 is counter, reset
70 PIN(2) = 1                                ' start charging & counting
80 PAUSE 5000                                ' wait for result
90 GOTO 40                                   ' repeat process
100 REM *******interrupt routine*******
110 PAUSE 1000                               ' wait for 4013 reset
120 PIN(2) = 0                               ' discharge cap
130 tim = PIN(11) *5                         ' calculate time
140 PRINT "time ";tim;" microseconds"        ' display time
160 PAUSE 2000                               ' wait a bit
170 IRETURN                                  ' exit interrupt, repeat
```



Numeracy trainer for young children

This circuit helps young children learn about numbers. It incorporates 10 blue LEDs and 10 momentary pushbuttons, labelled with the numbers 1-10. When one of these buttons is held down, a corresponding number of LEDs light up, allowing the child to understand the quantity each number represents.

The circuit is based around an LM3914 10-segment linear bargraph driver, with the pushbutton switches wired to a resistor ladder between the supply rails. When S1 is pressed, 1/10th of the 6V supply (ie, 0.6V) is applied to the pin 5 input of IC1.

When S2 is pressed, 2/10ths or 1.2V is applied and so on up to S10 which applies the full 6V. The 100kΩ resistor is effectively in parallel with the lower part of the divider but has little effect on the voltage applied; it is there to keep the pin 5 voltage at 0V when no buttons are pressed so that no LEDs light up.

The LM3914 contains a reference voltage source, a resistor ladder and 10 comparators to turn on the appropriate number of LEDs, depending on the voltage applied to its pin 5 input. It also contains 10 constant current sinks to drive the LEDs, providing consistent brightness between them.

While the LM3914 has an internal reference generator, the 6V reference voltage for the pushbutton resistor ladder is generated separately with a 7806 regulator (with appropriate input bypass and output filter capacitors).

While the circuit can be run off a 9V battery, it will give incorrect results once the battery voltage drops below about 8V as the 7806 regulator will enter dropout and the 6V reference output will no longer be correct. Using a 9V plugpack avoids this problem.

A. J. Lowe,
Bardon, Qld. ($45)

first no pulses are received and the Maximite's counter stays at zero.

It then brings its pin 2 output high which simultaneously begins charging the 4.7nF capacitor and starts the pulse counting by setting flipflop IC1a. The Maximite then executes a PAUSE command for five seconds, during which time its counter input measures the number of received pulses.

Eventually, the voltage across the 4.7nF capacitor is high enough to reset IC1a, via pin 4. Pin 2 of IC2a is then brought low and so the counting stops. At around this time, the Maximite interrupt routine should also trigger since its pin 1 input is also connected to the positive end of the 4.7nF capacitor.

Because the high-level thresholds for these two inputs (pin 4 of IC1a and pin 1 of the Maximite) are not necessarily identical, the Maximite code adds an extra 1-second pause before it reads the counter value, in case the flipflop is reset after the interrupt routine is triggered. The pulse counter value is then converted into a time and printed to the console and after a 2-second pause, the process repeats.

Jack Holliday,
Nathan, Qld. ($65)

Editor's note: if pin 1 of the Maximite is connected to pin 2 of IC1a instead of pin 4 and the 4.7nF capacitor, the extra 1s delay at the start of the interrupt handler routine is unnecessary. In this case, the interrupt must be set to trigger on a high-to-low transition rather than low-to-high.

SemTest

Pt.2: By JIM ROWE

Check all those semiconductors in your collection with this easy-to-build test set!

This month we present the full circuit of this versatile unit which can test all those semiconductors in your collection. It employs a PIC16F877A microcontroller to run all the different tests and displays the results on the 2-line LCD panel.

THERE'S QUITE A LOT of circuitry in the new SemTest, despite the fact that most of its operation is managed by a microcontroller. For that reason, the circuitry is accommodated on two PCBs which are stacked inside the case.

To begin the circuit description we will start with the lower or main PCB which carries the micro, the power supplies and metering. This section of the circuit is shown in Fig.5.

Microcontroller IC4 forms the brain of the SemTest. We have used a PIC-16F877A because it has five I/O ports, including three that are eight bits wide. It also includes a 10-bit A-D (analog-to-digital) converter with a choice of eight input channels.

All eight bits of both ports B and D are used to control the various relays which provide the test configurations. The two ports drive IC5 and IC6, which are ULN2803A octal Darlington arrays which in turn drive a total of 16 relays.

Most of these are on the upper PCB but four relays are on the main board:

- Relay 1, which is used to switch the device test voltage on and off;
- Relay 2, which switches the test voltage between its "BV" or "OPV" modes;
- Relay 7, which controls the value of the current shunt resistor used to measure device current (and hence switch current ranges); and
- Relay 8, which controls the voltage divider ratio for device voltage measurement (ie, to switch voltage measurement ranges).

The connections to the relays on the upper PCB are made via CON3 and CON4.

Bit lines RC0-RC3 of port C, together with RE0 and RE1 of port E, are used to control the LCD module, which is again on the upper PCB. These connections are made via CON2, which links to CON5 on the upper board via a 10-way IDC ribbon cable.

The remaining bit lines RC4-RC7 of port C plus bit line RE2 of port E are used to monitor activity on the five pushbutton switches S3-S7. These mount on the instrument's front panel and are connected using a 16-way IDC ribbon cable from CON7 on the upper PCB to CON4 on the main board.

The same connectors and cable are used to make the connections for relays 3-6, 9, 15 & 16, plus the connection for LED1 (the "Test Volts Present" indicator).

High-voltage supply

The test voltage power supply circuitry at upper left on Fig.5 has been adapted from the high-voltage power supply in the Electrolytic Capacitor Tester/Reformer described in August-September 2010.

As before, the supply is a step-up DC-DC converter using IC1 (an MC34063) as the controller, with transistors Q1 & Q2 used to drive Mosfet Q3 and transformer T1. The "flyback" voltage pulses developed by T1 are rectified by fast diode D2 and fed to the output filtering and current limiting circuitry. The MC34063 maintains the output voltage at the selected level by means of negative feedback from the four 75kΩ resistors in series with trimpot VR1 in the top leg, plus the 100kΩ resistor connected from pin 5 of IC1 to ground as the "default" bottom leg.

This basic divider determines the converter's nominal "10V" output level.

The three other operating test voltages (25V, 50V & 100V) are achieved using switch S2a to bring other resistances in parallel with the 100kΩ lower resistor, while relay 2(a) is used to achieve the converter's much higher (about 600V) "BV" output voltage by switching in a 680Ω resistor across the 100kΩ resistor instead.

Trimpot VR1 is used to set the converter's OPV output voltages precisely. Bit lines RA4 and RA5 of the micro's port A are used to sense the setting of switch S2, ie, via poles S2b and S2c.

While we're looking at the DC-DC converter circuitry, note that the second pole of relay 2 (2b) is used

Features & Specifications

Main Features

A compact yet flexible test set for most common discrete semiconductor devices, including diodes (junction and Schottky), LEDs, zeners, diacs, bipolar junction transistors (BJTs), Mosfets, SCRs and thyristors (including Triacs). Based on a PIC16F877A microcontroller, with device and test selection, plus the test results, displayed via a 16x2 alphanumeric LCD readout. Devices to be tested are connected to the test set via an 18-way ZIF socket.

Five test voltages are available: a 600V source for avalanche breakdown (BV) testing plus a choice of either 10V, 25V, 50V or 100V for operating voltage (OPV) tests. All test voltages are applied to the DUT via current limiting resistors – 100kΩ in the case of BV tests or 2kΩ in the case of OPV tests.

Maximum avalanche current which can flow during BV tests is 6mA (short circuit current).

Maximum device/leakage current which can flow with OPV = 100V is 30mA; with OPV = 50V is 25mA; with OPV = 25V is 12.5mA; and with OPV = 10V is 6mA.

Minimum leakage current which can be measured = 1μA.

Diode tests

(1) Reverse avalanche current I_R (BV)
(2) Reverse leakage current I_R (OPV)
(3) Forward voltage drop V_F (OPV)
(4) Zener/avalanche voltage V_R (BV)

LED tests

(1) Reverse leakage current I_R (OPV = 10V)
(2) Forward voltage drop V_F (OPV)

BJT tests

(1) Breakdown voltage C-B with emitter o/c $V_{(BR)CBO}$
(2) Breakdown voltage C-E with base o/c $V_{(BR)CEO}$
(3) Leakage current C-B with emitter o/c I_{CBO} (OPV)
(4) Leakage current C-E with base o/c I_{CEO} (OPV)
(5) Forward current gain h_{FE} with a choice of three base current levels: 20μA, 100μA or 500μA

Maximum h_{FE} which can be measured with I_B = 20μA is 1500 (OPV = 100V)
Maximum h_{FE} which can be measured with I_B = 100μA is 300 (OPV = 100V)
Maximum h_{FE} which can be measured with I_B = 500μA is 60 (OPV = 100V)

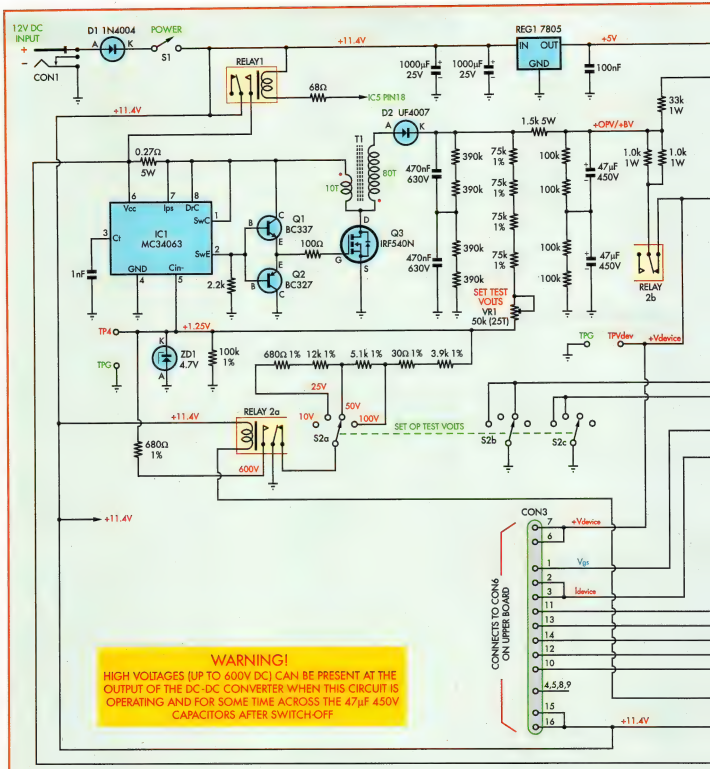
Mosfet tests

(1) Breakdown voltage D-S with G-S shorted $V_{(BR)DSS}$
(2) Leakage current D-S with G-S shorted I_{DSS} (OPV)
(3) D-S current I_{DS} versus G-S bias voltage V_{GS} (ie, gm)

SCR, PUT & Triac tests

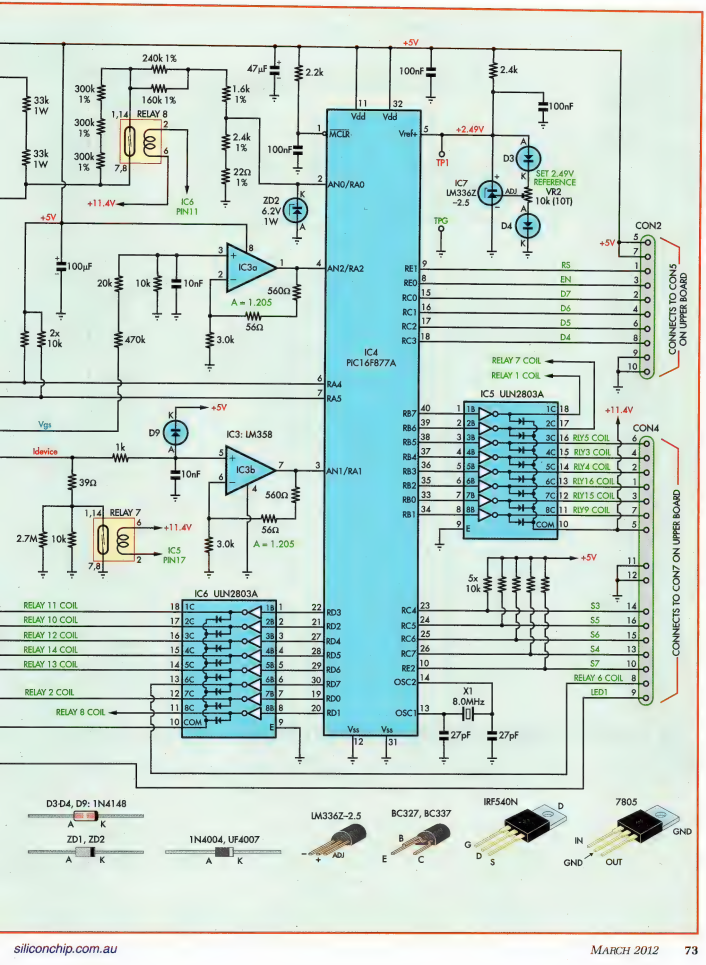
(1) Breakdown voltage with G-K (SCR) or G-A (PUT) shorted $V_{(BR)AKS}$
(2) Leakage current with G-K (SCR) or G-A (PUT) shorted I_{AKS} (OPV)
(3) Current I_{AKS} with gate current applied (20μA, 100μA or 500μA) and OPV applied
(4) Voltage drop A-K when conducting V_{AK} (OPV)

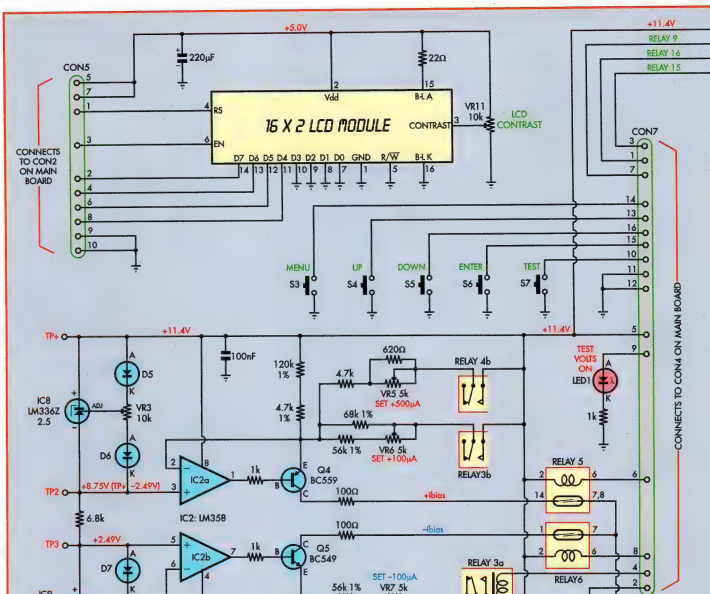
Note: the test set operates from an external power source of 12V DC. Current drain varies from around 65mA when a test is being set up, to a maximum of approximately 900mA during testing. It can therefore be powered from either a 12V SLA battery or a 12V/1A mains power supply or regulated DC plugpack.



SC 12012 SEMTEST DISCRETE SEMICONDUCTOR TEST SET — MAIN CIRCUIT (LOWER BOARD)

Fig.5: the main part of the SemTest circuit is built on the lower PCB and includes microcontroller IC4, the power supplies and metering. IC4 controls the relays via IC5 & IC6, performs A-D conversion of the measurements applied to its inputs and drives the LCD on the upper board via CON2. The test voltages (up to 600V) are generated by a DC-DC converter circuit based on IC1, transformer T1 and Mosfet Q3 at upper left.


240k 1%
300k 1%
160k 1%
1.6k 1%
RELAY 8
33k 1W
2.4k 1%
22Ω 1%
47µF
2.2k
100nF
2.4k
+5V
MCLR
Vdd
Vss
Vref+
+2.49V
TP1
D3
SET 2.49V REFERENCE
IC7 LM336Z-2.5
VR2 10k (10T)
D4
TPG
CON2
AN0/RA0
ZD2 6.2V 1W
IC6 PIN11
+11.4V
100µF
20k
10k
10nF
IC3a
560Ω
A = 1.205
56Ω
3.0k
2x 10k
470k
AN2/RA2
RE1
RE0
RC0
RC1
RC2
RC3
RS
EN
D7
D6
D5
D4
CONNECTS TO CON5 ON UPPER BOARD
IC4 PIC16F877A
RA4
RA5
RELAY 7 COIL
RELAY 1 COIL
IC5 ULN2803A
RB7
RB6
RB5
RB4
RB3
RB2
RB0
RB1
COM
RLY5 COIL
RLY3 COIL
RLY4 COIL
RLY16 COIL
RLY15 COIL
RLY11 COIL
CON4
Vgs
Idevice
D9
IC3: LM358
IC3b
1k
10nF
39Ω
560Ω
56Ω
3.0k
A = 1.205
AN1/RA1
2.7M
10k
RELAY 7
IC5 PIN17
5x 10k
RC4
RC5
RC6
RC7
RE2
OSC2
OSC1
S3
S5
S6
S4
S7
RELAY 6 COIL
LED1
CONNECTS TO CON7 ON UPPER BOARD
X1 8.0MHz
27pF
27pF
IC6 ULN2803A
RELAY 11 COIL
RELAY 10 COIL
RELAY 12 COIL
RELAY 14 COIL
RELAY 13 COIL
RELAY 2 COIL
RELAY 8 COIL
RD3
RD2
RD4
RD5
RD6
RD7
RD0
RD1
D3-D4, D9: 1N4148
ZD1, ZD2
1N4004, UF4007
LM336Z-2.5
BC327, BC337
IRF540N
7805
ADJ
GND
IN
OUT



SEMTEST DISCRETE SEMICONDUCTOR TEST SET UPPER BOARD CIRCUIT

Fig.6: the upper board circuit carries the LCD module, an 18-pin ZIF (zero insertion force) socket to connect the device under test (DUT), the control pushbuttons and various relays to switch the device connections to CON6.

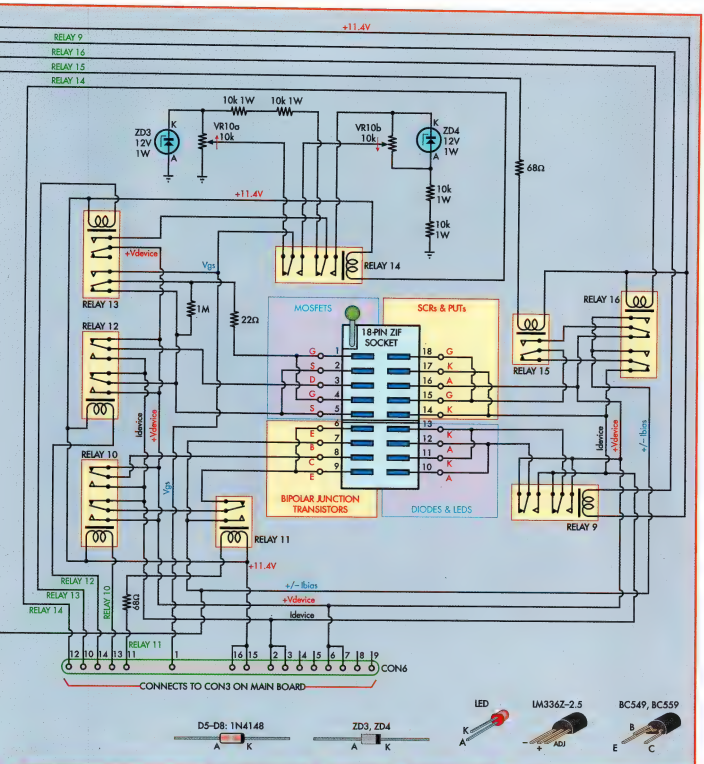
to adjust the value of the current limiting resistance in series with the converter's output, to suit the various output voltage levels. So for the four output voltage settings selected by S2a, the total current limiting resistance is (1.5kΩ + (500Ω//99kΩ)), or just under 2kΩ. This limits the device current to about 50mA on the 100V range.

On the "BV" setting (relay 2 off), the current limiting resistance jumps up to 100.5kΩ – limiting the maximum current to less than 6mA even if the device under test is shorted.

Crystal X1 and its two associated 27pF capacitors are used to run the micro at 8MHz, which gives an instruction cycle time of 500ns.

Analog-to-digital conversion

Now let's turn to the micro's ADC module and how it's used to perform the SemTest's various metering functions. Starting with the ADC's input



WARNING: SHOCK HAZARD!

The DC-DC step-up converter used in this project can generate high voltages – up to 600V DC – and can also supply significant current (tens of milliamps). As a result, it's capable of delivering a nasty electric shock and there are some situations where such a shock could be potentially lethal.

For this reason, DO NOT touch any part of the circuit while it is operating, particularly around transformer T1, diode D1 and the two 47µF 450V electrolytic capacitors on the main circuit (lower board). Note, however, that high voltages can also be applied to the display board (via CON6) during operation, so it's not safe to touch certain parts on this board either.

Provided the unit is built and fully-enclosed in a case as described, it's safe to operate. Exercise extreme caution if testing the unit with the lid opened and always allow time for the 47µF capacitors to discharge before working on the circuit.

This view inside the completed prototype shows how it all goes together. The two PCB assemblies are mounted in their respective case halves on spacers and joined together via three IDC header cables.

channel AN0 (IC4 pin 2), this is used to measure the voltage V_{DEV} being applied to the device under test. Relay 8 is used to switch the upper leg of the voltage divider feeding AN0 to give the V_{DEV} voltmeter two ranges: 0-1028V in the case of the higher "breakdown voltage" or BV range; and 0-102.8V for the lower "OPV" voltage range.

The second ADC input channel AN1 (IC4 pin 3) is used to measure the current I_{DEV} passing through the device under test (DUT). It does this by measuring the voltage drop across a shunt resistance connected between the negative end of the DUT and ground. Here, relay 7 is used to switch the value of the shunt resistor, to provide two current ranges.

When relay 7 is activated, it shorts the bottom end of the 39Ω "upper" shunt resistor to ground, giving an effective shunt resistance of 39Ω; this provides a 0-50mA current range. However, if the micro turns off relay 7, this removes the short across the paralleled 2.7MΩ and 10kΩ resistors, bumping up the effective shunt resistance to almost exactly 10kΩ and providing a 0-200μA current range.

On both ranges, the voltage drop developed across the shunt resistance is fed to the micro's AN1 input via buffer amplifier IC3b, which provides a gain of 1.205. This is used for scaling.

The third ADC input channel, AN2 (IC4 pin 4), is used to measure V_{GS}, the gate-source voltage for Mosfets. It does this by using another input voltage divider, with the top leg formed by the series 470kΩ and 20kΩ resistors, and the bottom leg by the 10kΩ resistor from pin 3 of IC3a to ground.

This gives a 50:1 input division, which together with the gain of buffer amplifier IC3a (again 1.205) gives a voltage range of 0-103.3V. This may seem too high for measuring voltages lower than 20V but it was only possible to give the AN2 voltmeter a single range and this needs to measure voltages up to around 100V to cope with V_{GS} measurements on P-channel devices (where the effective V_{GS} must

Parts List

1 ABS enclosure, 222 x 146 x 55mm (Jaycar HB-6130 or similar)
2 control knobs, 19mm diameter
5 SPST pushbutton switches, panel-mount (Altronics S1084, Jaycar SP-0700)
1 18-pin ZIF socket (Altronics P0590, Jaycar PI-6480)
1 18-pin machined IC socket
1 18-pin IC socket, wire-wrap type
4 M3 x 15mm tapped metal spacers
2 M3 x 6mm M3 tapped Nylon spacers
4 M3 x 25mm machine screws
2 M3 x 15mm machine screws
10 M3 x 6mm machine screws
10 M3 hex nuts
2 M3 flat washers, Nylon
4 16-way (8x2) IDC header sockets
2 10-way (5x2) IDC header sockets
4 16-way (8x2) pin headers, vertical PCB-mount
2 10-way (5x2) pin headers, vertical PCB-mount
1 300mm length of 16-way IDC ribbon cable
1 180mm length of 10-way IDC ribbon cable
1 16-way length of SIL pin header strip

Main board

1 PCB, code 04103121, 210 x 134mm
2 19mm square heatsinks (Altronics H 0630, Jaycar HH-8502)
1 6V SPDT mini relay (Jaycar SY-4058)
1 12V DPDT mini relay (Altronics S4150)
2 SPST mini DIL relay (Altronics S4101A)
1 Ferrite pot core, 25mm dia x 16mm high (Altronics L5300 or similar)
1 moulded bobbin to suit (L 5305)
1 M3 x 25mm Nylon machine screw plus nut and washer
1 3-pole 4-position rotary switch
1 SPDT sub mini toggle switch, PCB-mount (Altronics S 1320)
1 8.0MHz crystal, HC-49S (X1)
2 8-pin DIL IC sockets, PCB-mount
1 40-pin DIL IC socket, PCB-mount
1 2.1mm concentric DC connector, PCB-mount (Altronics P 0620)
2 Nylon cable ties
4 1mm PCB terminal pins
1 50kΩ multi-turn vertical trimpot (VR1)
1 10kΩ multi-turn horizontal trimpot (VR2)
1 1m length of 0.8mm-diameter enamelled copper wire
1 10m length of 0.25mm-diameter enamelled copper wire

Semiconductors

1 MC34063 switchmode controller (IC1)
1 LM358 dual op amp (IC3)
1 PIC16F877A microcontroller (IC4)
2 ULN2803A octal driver (IC5,IC6)
1 LM336Z-2.5 voltage reference (IC7)
1 7805 5V regulator (REG1)
1 BC337 NPN transistor (Q1)
1 BC327 PNP transistor (Q2)
1 IRF540N N-channel Mosfet (Q3)
1 4.7V 1W zener diode (ZD1)
1 6.2V 1W zener diode (ZD2)
1 1N4004 1A diode (D1)
1 UF4007 fast 1A diode (D2)
3 1N4148 100mA diode (D3,D4,D9)

Capacitors

2 1000μF 25V RB electrolytic
1 100μF 10V RB electrolytic
2 47μF 450V RB electrolytic
1 47μF 16V RB electrolytic
2 470nF 630V MKT capacitor
4 100nF MKT capacitor
2 10nF MKT capacitor
1 1nF MKT or polyester capacitor
2 27pF NP0 ceramic

Resistors (0.25W, 1%)

1 2.7MΩ	2 2.4kΩ
1 470kΩ	1 2.2kΩ
4 390kΩ	1 1.6kΩ
3 300kΩ	1 1.5kΩ 5W
1 240kΩ	1 1kΩ
1 160kΩ	2 1kΩ 1W
5 100kΩ	2 680Ω
4 75kΩ	2 560Ω
3 33kΩ 1W	1 100Ω
1 20kΩ	1 68Ω
1 12kΩ	2 56Ω
9 10kΩ	1 39Ω
1 5.1kΩ	1 30Ω
1 3.9kΩ	1 22Ω
2 3.0kΩ	1 0.27Ω 5W

Upper (Display) board

1 PCB, code 04103122, 200 x 124mm
1 16x2 LCD module (Altronics Z 7013; Jaycar QP-5512)
2 6V SPDT mini relays (Jaycar SY-4058)
8 12V DPDT mini relays (Altronics S4150)
2 SPST mini DIL relay (Altronics S4101A)
1 8-pin DIL IC socket
4 1mm PCB terminal pins
1 10kΩ mini horizontal trimpot
2 10kΩ multi-turn horizontal trimpot
1 10kΩ linear 16mm dual-gang pot
4 5kΩ multi-turn horizontal trimpot

Semiconductors

1 LM358 dual op amp (IC2)
2 LM336Z-2.5 (IC8,IC9)
1 BC559 PNP transistor (Q4)
1 BC549 NPN transistor (Q5)
2 12V 1W zener diodes (ZD3,ZD4)
1 5mm red LED (LED1)
4 1N4148 100mA diode (D5-D8)

Capacitors

1 220μF 10V RB electrolytic
1 100nF MKT capacitor

Resistors (0.25W, 1%)

1 1MΩ	2 2.2kΩ
2 120kΩ	3 1kΩ
2 68kΩ	2 620Ω
2 56kΩ	2 100Ω
4 10kΩ 1W	2 68Ω
1 6.8kΩ	1 22Ω
4 4.7kΩ	

be found by subtracting the actual V_{GS} from the device voltage V_{DEV}).

ADC reference voltage

The ADC reference voltage for all three of these measuring ranges is provided at pin 5 of IC4, by the voltage reference circuit based on IC7, trimpot VR2 and diodes D3 & D4, together with a 2.4kΩ load resistor. During set-up, VR2 is adjusted to bring the reference voltage across IC7 as close as possible to 2.490V, where it has a temperature coefficient that's very close to zero.

All three ADC input circuits have been designed to give the most accurate readings with this reference voltage, so this one adjustment per-

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forms the instrument's basic metering calibration.

That's just about it for the main PCB circuitry. However, before moving on, we should point out that the complete instrument runs from an external 12V DC supply which comes in via CON1, polarity protection diode D1 and power switch S1. The resulting +11.4V rail then feeds regulator REG1 (a 7805), which provides +5V to power IC3, IC4, the LCD module and their associated circuitry.

The +11.4V rail itself is also used to supply the various relays and the DC-DC converter based on IC1 – when the micro turns on relay 1 to begin a test. It's also used to power the I_{BIAS} circuitry on the upper PCB, as we shall see in a moment.

Incidentally, the overall current drain of the SemTest from the external 12V supply ranges from around 65mA when a test is being set up to between 150mA and 900mA during testing (depending on the test concerned). A regulated 12V/1A plugpack supply or a 12V SLA battery would be suitable.

The upper (display) PCB

Now we can turn our attention to the circuitry on the upper display PCB – see Fig.6. This has the LCD module and control pushbutton switch area at upper left. Trimpot VR11 is used to set the LCD's contrast for maximum readability and the four data lines (D4-D7) and two control lines (EN and RS) are fed from various pins on CON5 and linked back to CON2 on the main board. Similarly, the five pushbutton switches S3-S7 are simply wired to CON7, which is linked to CON4 on the main board and then to pins 23-26 & 10 of microcontroller IC4, so the micro can monitor them.

At lower left in Fig.6 are two programmable current sources, used to provide the base current I_{BIAS} for testing BJTs as well as the gate current for testing SCRs and PUTs. IC8, a 2.490V reference, together with op amp IC2a and PNP transistor Q4, is the positive I_{BIAS} source. Similarly, voltage reference IC9, IC2b and NPN transistor Q5 is the negative I_{BIAS} source (or "sink", if you prefer).

The 2.490V voltage references (IC8 or IC9) are connected to the non-inverting input of their respective op amps, ie, IC2a or IC2b. The output of each op amp drives the base of the current pass transistor (Q4 or Q5), while feedback to the inverting input of each op amp is taken from the emitter of its pass transistor. Then the emitter of each transistor is taken either to the +11.4V rail (in the case of Q4) or to ground (in the case of Q5), via a series resistance whose value is carefully chosen to have a voltage drop of 2.490V when the transistor's emitter current is at the desired level.

For example, when relays 3 and 4 are both off, the emitter resistances for Q4 and Q5 are both equal at 124.7kΩ (120kΩ + 4.7kΩ). As a result, the current passed by either transistor will tend to stabilise at 20μA, ie, the level which results in a voltage drop of 2.490V across its emitter resistance.

Relays 3 & 4 are used to switch in different values of emitter resistance for transistors Q4 and Q5, to change the operating currents. For example when relay 3 is energised by the micro, the 68kΩ and 56kΩ resistors plus trimpot VR6 (or VR7) are switched in parallel with the fixed emitter resistors, changing the current level of each source to 100μA.

Similarly, when relay 4 is energised, the combinations of 4.7kΩ and 620Ω resistors plus trimpot VR5 (or VR8) are switched in parallel with the fixed emitter resistors, changing the current level of each source to 500μA. So that's how we program the I_{BIAS} current sources for currents of either 20μA, 100μA or 500μA.

Relays 5 & 6 are used to switch the output of either the upper +I_{BIAS} source or the lower -I_{BIAS} source, to the device test circuitry. By the way, when either relay 5 or relay 6 (or both) are off, the current sources obviously can't provide any of the three preset current levels. The op amp comparators simply bias their pass transistors "hard on", ready to pass the appropriate current when current is able to flow.

That covers pretty well all of the circuitry on the lefthand side of Fig.6, apart from LED1, the "Test Volts On" indicator. This is connected between pin 9 of CON7 and ground, via a series 1kΩ resistor. If you refer back to Fig.5, you'll see that the LED is connected to the +11.4V rail whenever relay 1 switches on the DC-DC converter circuitry, to perform a test.

ZIF socket

In the centre of the righthand side of Fig.6 you'll see the 18-pin ZIF socket

that's used to connect the various types of discrete semiconductor device to the SemTest. The socket's pin clips are divided into four groups: four for BJTs at lower left, five for Mosfets at upper left, five for SCRs and PUTs at upper right and the remaining four for diodes and LEDs at lower right.

You'll also note that within each device group there are some clips connected together; this has been done to provide for as many pin-out configurations as possible, for each type of device.

Upper board relays

Shown around the ZIF socket are the various relays used to set up the connections for each device type: relay 9 for diodes and LEDs, relays 10 & 11 for BJTs, relays 12, 13 & 14 for Mosfets and relays 15 & 16 for SCRs and PUTs. If you want to trace out the four separate relay circuits you will find this easier by referring back to the simplified circuits given in Figs.1-4 in the first article.

The only other part of the circuitry on the righthand side of Fig.6 is that at top centre, associated with zener diodes ZD3 and ZD4 and pots VR10a and VR10b. These are used to adjust the gate bias voltage, V_{GS}, for Mosfets, which was also shown in Fig.3 of the first article.

VR10a is used to adjust the positive V_{GS} for N-channel Mosfets, while VR10b is used to adjust the "negative" V_{GS} for P-channel Mosfets.

In operation, the microcontroller works out the effective V_{GS} for the latter devices by subtracting the actual voltage at VR10b's wiper from the device voltage V_{DEV} (which in this case corresponds to the source voltage).

That completes the circuit description. Next month, we will present the construction details. SC

Another view inside the prototype SemTest. The full assembly details will be described in Pt.3 next month.

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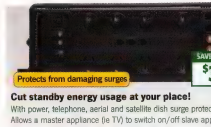

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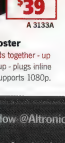
A useful tool for tuning high end home theatre & car audio systems.
Measures sound up to 130dB (1.5dB accuracy). Great for live venues, installers, pubs etc. Includes 9V battery.



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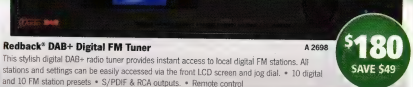

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This stylish digital DAB+ radio tuner provides instant access to local digital FM stations. All stations and settings can be easily accessed via the front LCD screen and jog dial. • 10 digital and 10 FM station presets • S/PDIF & RCA outputs. • Remote control

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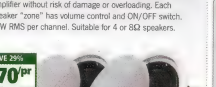

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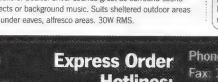

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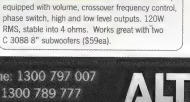

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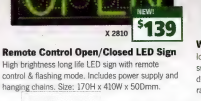

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Re-assembles into a new machine in an hour!

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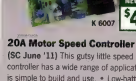
NEW KIT!
K 6007
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20A Motor Speed Controller Kit
(SC June '11) This gutsy little speed controller has a wide range of applications and is simple to build and use. • Low-battery protection • Soft start • Adjustable pulse frequency. • Runs from 12V or 24V batteries at currents of up to 20A.

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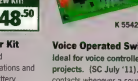
(SC May '11) Why put up with garbage sound from your portable music player? This compact device not only boosts the volume output of your device, but significantly improves fidelity - lowering distortion & noise. Provides up to 200hrs use from 2xAA batteries (not included)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K 5542
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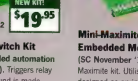
(SC Dec '04) Extremely simple amplifier kit designed to be easy enough for beginners to assemble. Delivers 20W RMS and is suitable for mini hi-fi or a PC sound system. Power supply kit to suit, K 5117 $14.95.


NEW!
K 9552
NEW KIT!
$49.95

Mini-Maximite BASIC Embedded Module Kit
(SC November '11) The 'little brother' of the Maximite kit. Utilising identical software it is designed as an intelligent controller for embedding into larger systems. Features 20 I/O pins, 128K RAM, VGA/composite out, USB2.0 & keyboard interfaces. All from one low cost IC!

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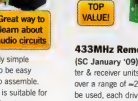
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Review: APx525

By ALLAN LINTON-SMITH & NICHOLAS VINEN

As with previous Audio Precision analysers, the APx525 is essentially a computer peripheral. It relies quite heavily on digital signal processing and much of this is done using the host PC, connected via USB 2.

This is much more convenient than the dedicated interface cards needed for some of the older analysers and a mid-range laptop is more than enough to drive it. Everything is controlled by the computer and the analysis results are displayed on its screen.

The APx525 adds many new features and capabilities compared to its predecessors. Its design was influenced by an internet survey of engineers and Audio Precision users. The results of this survey showed a need for a digital audio analyser with HDMI and Bluetooth interfaces along with a variety of other wish list items. The result is an unprepossessing instrument 432 x 467 x 129mm, weighing 10.9kg.

There are no controls on the unit itself – the front panel consists mainly of input and output connectors to interface the unit with the device under test (DUT).

In addition to the XLR, BNC and banana connectors for the balanced and unbalanced stereo audio inputs and outputs, it has TOSLINK, BNC and XLR (AES/EBU) sockets for digital audio input and output.

Using the software, you can easily set it up to use any combination of these, to suit the instrument you are testing.

The digital audio interface supports sampling rates of 22kHz-192kHz and resolutions of 8-24 bits. As well as linear PCM, the digital output can generate Dolby Digital and DTS signals, to interface with home theatre gear.

HDMI, Bluetooth and other interfaces are added with optional modules – there is space for both.

The combination of analog and digital inputs and outputs allows a variety of equipment to be tested. You can test analog devices such as preamps, amplifiers and filters but then you can also test DACs (digital-to-analog converters) or digital home theatre receivers using a combination of the digital output and analog inputs.

Similarly, to test an ADC (analog-to-digital converter) you would use the analog outputs and digital input. Devices containing DSPs (digital signal processors) can be tested using just the digital inputs and output.

Audio Precision Audio Analyser

SILICON CHIP has a long record of using the latest available instruments to validate our designs – typical of this has been our use of the Audio Precision System One to measure all our high performance audio designs. This month we review the latest such instrument from Audio Precision, the APx525.

Basic Specifications:

- Output frequency range: 0.1Hz-80.1kHz
- Output frequency accuracy: 2 ppm
- Maximum output amplitude: 30V peak
- Maximum input voltage: 300V RMS (balanced) /160V RMS (unbalanced)
- Input bandwidth: >90kHz
- Input/output amplitude accuracy: ±0.05dB
- Input/output amplitude flatness: ±0.008dB
- Residual input noise: 1.3μV
- Input/output residual THD+N: -105dB + 1.4uV
- Digital sampling rate: 22kHz-192kHz
- Digital output formats: PCM, Dolby Digital, DTS

Performance

The new features of the APx525 make testing audio equipment easier and gives more comprehensive results. But what about the performance? In the digital domain of course there isn't really any distortion apart from the limitations of the digital format itself. But when testing analog gear you don't want the analyser's own noise and distortion to interfere with the measurements you are making.

The good news is that the on-board analog signal generators are capable of delivering a very low distortion analog signal, to less than 0.0002% (-114dB) and the input circuitry is equally good. Audio Precision is promoting it as the "second best" audio analyser in the world for THD+N (total harmonic distortion plus noise) measurements, the "best one" being their 2700 series! That's when it's fitted with the AG52 (Advanced Analog Generator), a roughly $1000 option. The standard unit is rated for a typical residual distortion of 0.0004% (-108dB), which is slightly better than our System One.

On the demonstrator unit, we actually measured a THD+N of 0.00025% (-112dB) from the analog loop-back test, despite it not being fitted with the AG52 option. We expect if it were fitted, we could have easily achieved the stated figure of 0.00018% (-115dB).

Features

The software provided with the unit is easy to use and it quickly became apparent that the APx525 can do many things that our System One can not.

It has a number of new test modes which can give important insights into the performance of the DUT and it also provides the ability to automate a large number of tests with the press of a button – something that could come in very handy when comparing the performance of similar units or during R&D when you want to see the precise effect of a design tweak.

It's also a boon for production testing. Because this unit uses digital processing, it can easily distinguish between THD+N and harmonic distortion (ie, THD without the noise component). It can even show you the contribution each individual harmonic makes to the overall distortion of the waveform.

Alternatively, you can look at the output of the inbuilt spectrum analyser to see the relative height of the peaks at each harmonic frequency. This

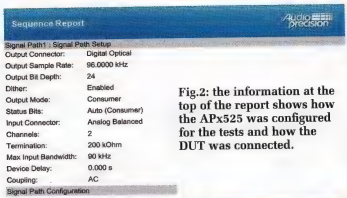
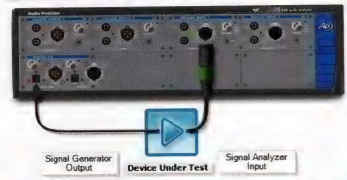


Fig.2: the information at the top of the report shows how the APx525 was configured for the tests and how the DUT was connected.



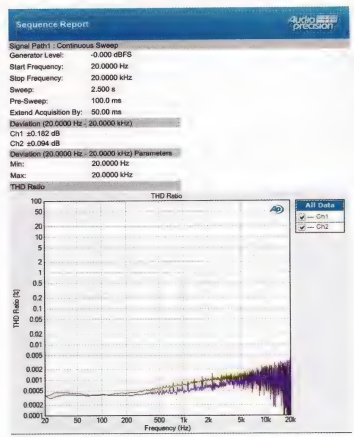


Fig.3: each test result in the report shows the parameters of the test with the results below. In this case, it is a continuous sweep test of THD. We set it to the maximum sweep time of 2.5s; the default is less than a second and in this time the unit can generate THD, THD+N, frequency response, inter-channel phase and a whole slew of other graphs. This also shows the very low distortion levels this unit can measure at around 0.0004%.

analyser can be left running permanently in the corner of the software while you are running other tests or it can be maximised to see more detail.

The FFT can be set up with a very large window (1M) and wide bandwidth (up to 100kHz). With the averaging option enabled, it gives a noise floor around -160dB! You can therefore clearly see all the harmonics and their intermodulation products (see Fig.4).

Speaking of averaging, another handy feature of the instrument is the ability to automatically perform a measurement several times and average the result. This allows you to easily ignore artefacts in the test results which may be due to external interference (eg, from nearby mains-powered equipment) or to further reduce measurement noise.

Measurements

There are six main measurements which show all the most important aspects of a given device. Audio Precision call them "the big six" and these are the default measurements enabled when you start a new project. These are:

- Level and Gain
- THD+N
- Frequency Response
- Signal to Noise Ratio
- Crosstalk
- Inter-channel Phase

It can run many more tests though, including CMRR (common mode rejection ratio), IMD (intermodulation distortion), stepped level and frequency sweeps (to give you THD+N vs power, THD+N vs frequency), dynamic range, burst (peak output) tests, etc.

Many of the tests can be run in different modes. For example, THD+N vs frequency can be measured using a stepped frequency sweep, continuous sweep, multi-tone burst or impulse mode.

One of the brilliant aspects of this unit is that you only need to run the continuous sweep, multi-tone burst or impulse tests once and you get a whole slew of results including THD+N, phase response and crosstalk.

We found that the continuous sweep tests also gave better frequency resolution and detail compared to the stepped sweep (see Fig.3) although there are still times when the stepped mode is preferable.

Returning to the standard or "streaming" measurements, these can be made with stimulus signals other than sine waves. This includes:

- Mixed twin tone Sine wave
- Special Sine wave
- Square wave
- Mixed square wave and sine wave
- Arbitrary waveform (loaded from hard disk or CD) and
- Diagnostic digital signal

Software

The software for this unit requires Windows XP SP2 or later and fully supports 64-bit Windows which is good since it is becoming very common and is pre-installed on most new computers. The stated requirements are 2GHz+ CPU and 2GB+ of RAM, which means it will run on most computers purchased within the last year or so. A screenshot is shown in Fig.5 and the photo on p84.

Being familiar with the Audio Precision System One and audio gear testing in general, despite the plethora of

new features, we figured out the APx525 software straight away. It's intuitive and well-organised although it has a few quirks which threw us off at first, since we are so used to the older APWin software.

For any features which are not obvious, you can refer to the 636-page printed manual. It is clearly written and comes with good explanations of each feature and function, including the optional ones. They even go to the trouble of explaining the basic principles of each measurement; just the thing to flip through when you are in the mood for a little light reading!

The software provided with the machine was already out of date when we received it but it was a simple matter of downloading the latest version (2.9, 103MB) from the Audio Precision website (http://ap.com).

One of the best features of the software is the ability to create your own "project". The project defines the test set-up and consists of any number of individual tests, each configured as required. It's then just a matter of pressing a button and the instrument runs through them all.

The result is a PDF which includes information on the test set-up (see Fig.2) as well as all the figures and graphs (see Fig.3). Very handy!

The tests to run are selected from the tree list at the left side of the screen and the settings for each is displayed on the right when it is selected. Each option for a test (bandwidth, start/stop frequency, sweep time etc) can then be adjusted. You can also control the formatting of the resulting graph: axes, trace styles and so on. It's pretty easy once you understand how the tests work.

For use on a production line, all the test measurements can be preset and locked in. The instrument can also be set up with limits and will simply display a "go" or "no go" to indicate whether the DUT is operating to spec.

Options

As well as the aforementioned HDMI and Bluetooth options, you can also get a separate input/output switching unit that plugs into the Aux Control sockets on the back of the APx525. This is then controlled by software and allows an even greater degree of testing automation, suitable for use in production lines and so on.

The HDMI option interfaces with the digital audio I/O on the unit and is features the same PCM, Dolby Digital and DTS signal handling.

Since HDMI carries audio and video, the video stream can either be an internally generated test pattern or supplied by external equipment. The APx525 and its siblings are currently the only distortion analysers we know of with HDMI support.

For Bluetooth, the unit supports HFP and HSP profiles for voice and A2DP for music. With A2DP, it can operate as either an audio source or sink (not both) while the other profiles are bidirectional (full duplex).

The APx-AG52 option, mentioned earlier as giving lower distortion residuals, also allows the signal generator to produce fast rise/fall time square waves. It is also required for the DIM IMD (intermodulation distortion) test modes (but not the SMPTE, MOD or DFD IMD modes which are supported by the base unit).

The APx-BW52 (Ultra-high Bandwidth) option extends the bandwidth to 1MHz for one channel or 500kHz for two channels. This is useful for observing very high order harmonics and digital switching noise in audio signals.

The DSIO (Digital Serial I/O) option adds serial audio I/Os to the front panel, allowing direct interfacing with DACs, ADCs and DSPs. It enables devices to be more easily tested at the board level and supports I^2S and similar formats, with up to eight channels.

Other models

There are four models in this range:

- APx520 – two channels, analog I/O only
- APx521 – four channels, analog I/O only
- APx525 – two channels, analog and digital I/O (reviewed

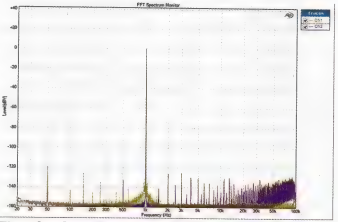


Fig.4: this shows the APx525's FFT display with the maximum window size (1M) and 8x averaging. The noise floor is extremely low (-160dB). Ch1 shows the residual distortion from our Audio Precision System One's analog signal generator at 1kHz while the mauve display underneath shows the output from the APx525's own signal generator. The APx525 has less 50Hz hum and less spread around the 1kHz fundamental but more high-frequency noise.

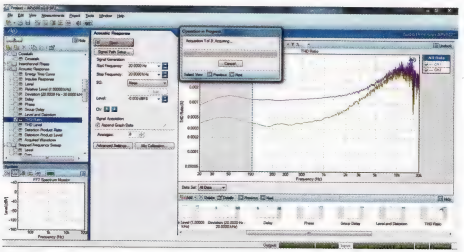


Fig.5: another screenshot, this time showing more test options at the left. The instrument is running an acoustic response test and is set up to average the result of eight runs. Between the list of tests at the left and the result graph at the right are the settings for the current test. The status bar at the bottom shows how the instrument has been configured.

This close-up of the front of the APx525 shows that it is not designed to win any beauty pageant . . . but it will win when it comes to function and operation!

here)

- APx526 – four channels, analog and digital I/O

There are several other current Audio Precision models, both cheaper and more expensive but those are outside the scope of this review.

Drawbacks

While this new unit has a lot more features than our System One, it has unfortunately lost some too. One of the biggest drawbacks that we noticed straight away is that there's no good way to monitor the distortion residual waveform (ie, the actual distortion waveform being introduced) during a test.

With our System One, we monitor the residual whenever we are using it. It gives important clues as to the behaviour of the DUT and the nature of the distortion. Unlike the System One, the APx525 has no output sockets to hook up to a scope. It does have the facility to view the test waveform on the computer screen but this does not update very fast and there's no way to view the residual synchronised to the test signal itself.

You could argue that having a spectrum analyser means you don't need to see the residual in this manner but while the spectrum analyser is an excellent feature, we don't think it really replaces being able to see the distortion waveform itself.

For example, it's easy to see whether an amplifier is suffering from crossover distortion by looking at the residual as the spikes occur near the zero crossing of the test signal. How do you make the same diagnosis from a frequency spectrum display? It's possible but nowhere near as easy.

We also found it a bit odd that when you generate a PDF of your test results, the embedded graphs are just bitmaps rather than vector plots.

As a result, they look quite grainy when printed. When we used the APx525 to test our Crystal DAC project (February 2012), which we happened to be working on at the time, we ended up tracing the curves to get graphs we could publish. This could obviously be fixed with a simple software upgrade or alternatively, you can export test results as a CSV file and plot them yourself using spreadsheet or graphing software.

The analog outputs of the APx525 are generated using internal DACs. This means that while they have extremely low distortion with a 22Hz-22kHz bandwidth, if the bandwidth is opened up (say, to 80kHz) there is a measurable increase in noise. In fact, with a 22Hz-80kHz bandwidth, the analog signal generator in our System One gives a lower THD+N figure. This is not a major problem but it goes to show just how good the System One was for its time (see Fig.4).

Conclusion

Overall the instrument is easy to use, has a slew of useful automated tests and we found ourselves using it in preference to our System One most of the time, especially due to the ease of automating tests and the digital audio I/O. We hardly had to refer to the manual at all.

The APx525 is available from VICOM Australia Pty Ltd, Level 4, 71-79 Parramatta Rd Silverwater NSW 2128. Contact them at (02) 9648 4757. The cost at the time of writing is approximately $13,360 and the AG52 option is $1,380. The HDMI + Bluetooth option is approx $10,000. SC

And if you thought the front panel was rather spartan, here's the back of the machine to prove it too is very utilitarian! Apart from the ubiquitous IEC mains input connector, all you have is a couple of D9 connectors for aux control in and out, another for software options and a mini-USB for computer interface.

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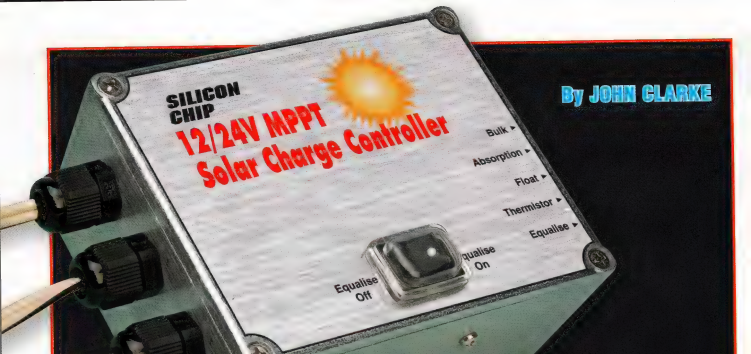


By JOHN CLARKE

12/24V MPPT Solar Charge Controller Rev.1

The 3-stage MPPT Solar Charge Controller has been a popular project and one year later we have been able to make some useful improvements to its efficiency and include some extra charging options. The design retains the features of maximum power point tracking (MPPT) for optimum power delivery from solar panels and 3-stage charging for lead-acid batteries.

AS PRESENTED in February 2011, the MPPT Solar Charge Controller was designed for use with 12V solar panels rated up to 120W or 24V solar panels up to 240W. A number of readers have requested modifications to allow it to be used with larger panels. Unfortunately, that's not practical because the necessary component changes required for more power cannot be accommodated within the existing box size or on the PCB.

We may publish a higher power MPPT Charge Controller at a later date but for now, we are simply presenting some enhancements to the original design, to make it run cooler and more flexible to use. The increased efficiency will be a significant improvement where the Charge Controller is being used inside a vehicle and is subjected to high ambient temperatures.

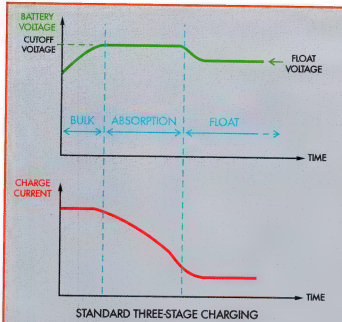
The software in this revised design adds some options to the way the charger functions. As originally presented, the 3-stage charging feature includes bulk charging, an absorption phase and float charging. Plus there is the option to periodically run equalisation to make sure that all cells in the battery or battery bank have been equally charged.

Fig.1 & Fig.2 show graphical representations of these charge modes.

During bulk charge, maximum power is extracted from the solar panel, using the MPPT system, to charge the battery.

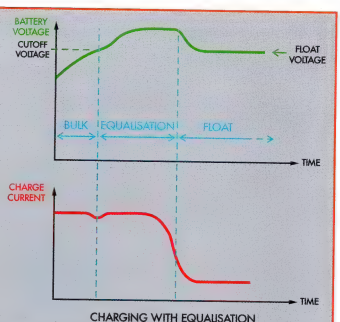
Bulk charging ceases when the battery voltage reaches a cut-out voltage of 14.4V. This applies to a temperature of 20°C. It is compensated for other temperatures and is inversely proportional to increasing battery temperature; if the battery is hot, the cut-out voltage is reduced.

The absorption charging stage then maintains the cut-out voltage (ie, 14.4V) across the battery for an hour to ensure the battery is fully charged. After this period, the charger switches



STANDARD THREE-STAGE CHARGING

Fig.1: the three standard battery charging stages. First is the initial bulk charge. Once the battery reaches the cut-off voltage, the absorption stage takes over to fully charge it. Finally, the float stage maintains its charge.



CHARGING WITH EQUALISATION

Fig.2: the charging cycle with equalisation enabled. Instead of the absorption stage, the battery voltage is allowed to rise by 10% over the cut-off voltage to cause gassing within the cells. This charges the cells equally.

to float charge whereby the battery voltage is maintained indefinitely at 13.5V at 20°C. Again, temperature compensation reduces the float voltage with increasing temperature.

Normally, the MPPT Solar Charge Controller is left permanently connected to the battery or battery bank and for perhaps most of the time during daylight hours, the battery will be on float charge. Then, when a load is placed on the battery, the Controller reverts to the bulk charge mode when the battery voltage falls below 12.45V.

The figure of 12.45V is somewhat arbitrary but is a level at which it is certain there is still substantial charge remaining in the battery.

During absorption and float charging and whenever a load is placed on the battery, the charger's current increases up to the maximum that can be derived from the solar panel. Only if the battery voltage drops below 12.45V will the charger revert to bulk charge.

Some constructors found that the charger did not reliably start bulk charging when the battery dropped to 12.45V. The battery monitoring settings are critical in this regard.

Some constructors of the MPPT Charger would also have preferred the battery to be bulk charged each day at the onset of daylight, as soon as the solar panels start to produce power. Additionally, they wanted the Controller to revert to bulk charge from float charge whenever power is drawn from the battery. This would then occur before the battery voltage falls to 12.45V.

Both options have been incorporated into this revised design and they can either be selected independently or together. With neither option selected, the MPPT Controller will operate under have the original arrangement, with bulk charge cutting in whenever there is less than 12.45V across the battery.

Other software refinements

With the first option selected, bulk charge is initiated each morning as soon as the solar panel starts generating power. The second option switches the Controller from float to bulk charge whenever power to maintain float charge is greater than that required just to maintain the battery in float.

However, if bulk charging begins

WARNING!

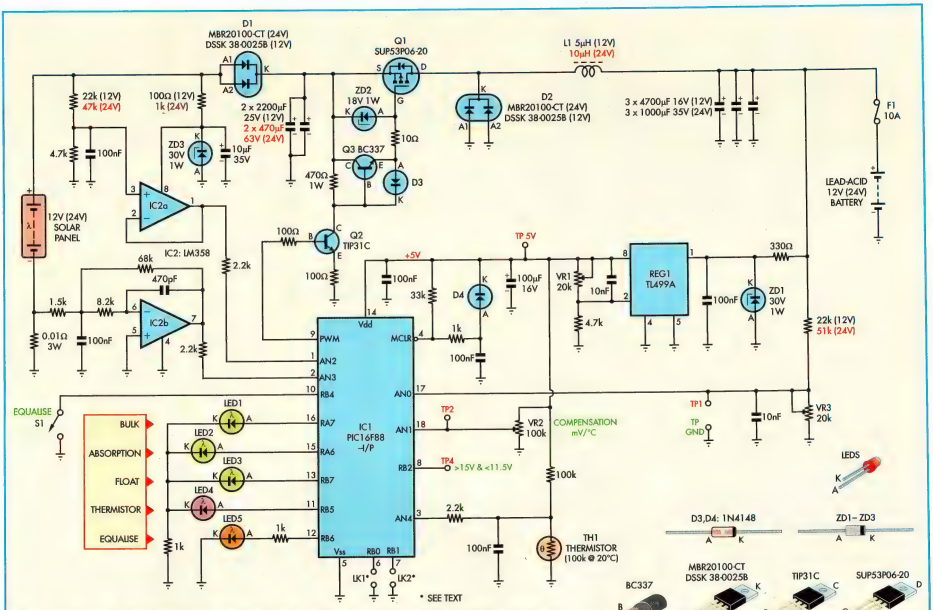
When charging with the equalisation cycle, the battery will produce hydrogen gas which is explosive. **For this reason, make sure that the battery is located in a well-ventilated area during charging.**

Additionally, if equalisation is used, the battery voltage will rise above 15V and this could damage any equipment connected to it. If there is any risk of damage to such equipment, it should be disconnected during equalisation.

A test point (***TP>15V & <11.5V***) is provided on the PCB and this point goes to +5V when the battery goes above 15V during equalisation. This output could thus be used to automatically disconnect equipment when the voltage goes above 15V.

A suitable circuit for doing this is the DC Relay Switch published in Silicon Chip, November 2006. However, a latching relay switch would be more effective for this application since the relay only draws power when switching. A suitable latching relay circuit was published in June 2011.

Note that the ***TP>15V & <11.5V*** output also goes to +5V if the battery voltage drops below 11.5V and only returns to 0V when the battery subsequently rises above 12V. As a result, this output can also be used to disconnect equipment when the battery voltage is low, to prevent over-discharge.



SC 12/24V 3-STAGE MPPT SOLAR CHARGE CONTROLLER, REV.1

Fig.3: the circuit for the 12/24V Solar Charge Controller is based on PIC16F88-I/P microcontroller IC1. This monitors the solar panel voltage and current, the battery voltage, temperature (via the NTC thermistor), the compensation trimpot position and the equalisation switch S1. The resulting PWM (pulse width modulation) output on pin 9 of IC1 then drives Mosfet Q1 via transistors Q2 & Q3, while several other outputs drive the charge indication LEDs.

at the start of each day, it is highly likely that the battery may already be fully charged and so does not need bulk charging. If it was bulk-charged, it would would quickly reach the cut off voltage. In this case, it is not necessary or good practice to then have a further hour in the absorption charge phase at 14.4V.

Hence the Controller now monitors the time the Controller stays in bulk-charge mode. Should the battery reach the cut off voltage during bulk charge in less than one minute then the absorption phase is bypassed and the Controller will switch directly from bulk to float.

The second software change involves detecting the start of a new day. The software needs to differentiate between the start of a new day and lifting of heavy cloud-cover or after a total solar eclipse; admittedly this last event is rare, the next one in Australia being in November 2012.

Without correct detection of the start of a new day, the Controller could incorrectly initiate bulk charging throughout the day. So to detect the start of new day, the software monitors how long the solar panel fails to produce power. If it is four hours or more, it is deemed to be a new day, to allow bulk charge to begin.

Efficiency improvements

More important than the software refinements are the changes to gain improved efficiency. While the original circuit is still valid, we have now specified a new Mosfet with much lower on-resistance, (RDSon). In addition, if you're using the Charge Controller with 12V solar panels, you can use new double-Schottky diodes which have much lower forward voltage.

With these points in mind, let's have a look at the revised circuit of Fig.3. It is virtually the same as that published in February 2011 except that we are now employing the RB0 and RB1 inputs at pins 6 & 7 of the PIC16F88 microcontroller (IC1). These are used to select the charger options. Leaving these two inputs unconnected selects the standard option whereby bulk charging begins when the battery voltage drops below 12.45V. Table 1 shows the selections available with either or both LK1 and LK2 connecting the relevant pins to ground.

Note that the LK1 connection is made using a solder bridge between

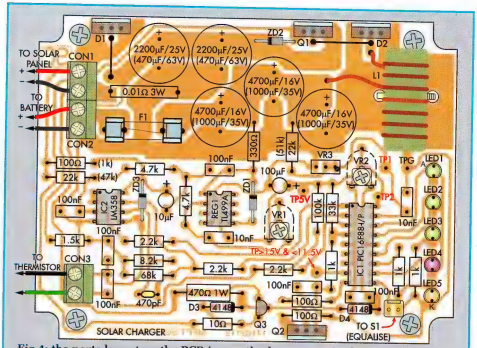
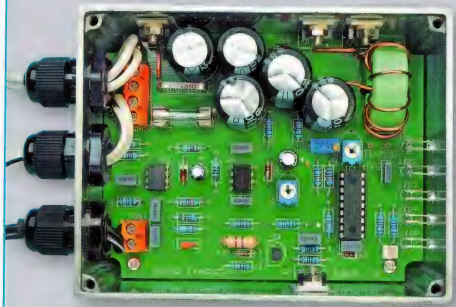


Fig.4: the parts layout on the PCB is exactly the same as in the February 2011 article with the exception of the LK1 & LK2 linking options (see Table 1 below). The links are installed using solder bridges, as described in the text.



This is the view inside the completed unit. Note the extra cable gland at bottom left. This allows a figure-8 cable to be run to the external thermistor which must be mounted next to the battery to obtain accurate readings – see Fig.5.

Table 1: Charging Options

LK1	LK2	Operation
Out	Out	Bulk charge initiated if battery <12.45V
In	Out	Bulk charge initiated each morning (and when battery falls below 12.45V)
Out	In	Switches from float to bulk charge when power is drawn from the battery or when battery falls below 12.45V)
In	In	Bulk charging each morning and switching from float to bulk charge when current is drawn from the battery or when <12.45V

Parts List For MPPT Solar Charge Controller

1 PCB, code 14102112, 111 x 85mm (original 14102111 can be used – see text); available from Silicon Chip for $25 + $10 p&p
1 diecast aluminium case, 119 x 94 x 57mm
3 IP65 cable glands for 4-8mm diameter cable
3 2-way PC-mount screw terminal blocks, 5.08mm pin spacing
1 SPST mini rocker switch (S1)
1 waterproof switch cap (optional)
1 2-way PC-mount polarised locking pin header (2.54mm pitch)
1 2-way polarised header socket with 2.54mm pin spacing
2 M205 PC-mount fuse clips
1 M205 10A fuse (F1)
1 NTC thermistor, 100kΩ at 25°C (TH1)
1 DIP18 IC socket
1 iron-powdered toroidal core, 28 x 14 x 11mm
4 TO-220 mounting kits (insulating bushes and silicone washers)
4 M3 x 15mm tapped Nylon spacers
4 M3 x 12mm countersink Nylon screws
4 M3 x 10mm machine screws
4 M3 x 6mm machine screws
4 M3 nuts
1 400mm-length of 1.25mm enamelled copper wire
1 50mm-length of medium-duty hookup wire
1 1m length of light-duty Fig.8 wire
1 25mm length of 6mm-dia. heatshrink tubing
1 50mm length of 2.5mm-dia. heatshrink tubing
5 PC stakes
1 100mm cable tie
1 20kΩ horizontal-mount trimpot (VR1)
1 100kΩ horizontal-mount trimpot (VR2)
1 20kΩ multi-turn top adjust trimpot (VR3)

Semiconductors

1 1 PIC16F88-I/P microcontroller programmed with 1410211B.hex (IC1)
1 LM358 dual op amp (IC2)
1 TL499A regulator (REG1)
1 SUP53PO6-20 60V 53A P-channel Mosfet (Q1) (Element14 Cat. 1684102)
1 TIP31C NPN transistor (Q2)
1 BC337 NPN transistor (Q3)
2 MBR20100CT 10A 100V double Schottky diodes (D1, D2) (24V version)
2 IXYS DSSK 38-0025B dual 25V, 20A Schottky diodes (D1,D2) (12V version only) (Element14 Cat. 1080066)
2 1N4148 switching diode (D3, D4)
2 30V 1W zener diodes (ZD1, ZD3)
1 18V 1W zener diode (ZD2)
3 3mm green LEDs (LEDs1-3)
1 3mm red LED (LED4)
1 3mm orange LED (LED5)

Capacitors

3 4700µF low-ESR 16V PC electrolytic
2 2200µF low-ESR 25V PC electrolytic
1 100µF 16V PC electrolytic
1 10µF 35V PC electrolytic
6 100nF MKT polyester
2 10nF MKT polyester
1 470pF ceramic

Resistors (0.25W, 1%)

1 100kΩ	1 1.5kΩ
1 68kΩ	3 1kΩ
1 33kΩ	1 470Ω 1W
2 22kΩ	1 330Ω
1 8.2kΩ	3 100Ω
2 4.7kΩ	1 10Ω
3 2.2kΩ	

1 0.01Ω 3W resistor (Welwyn OAR3-R010FI) (Element14 Cat. 120 0365)

Parts For 24V Operation

3 1000µF low-ESR 35V PC electrolytic capacitors (instead of 3 x 4700µF 16V)
2 470µF low-ESR 63V PC electrolytic capacitors (instead of 2 x 2200µF 25V)
1 51kΩ 0.25W 1% resistor (instead of 22kΩ)
1 47kΩ 0.25W 1% resistor (instead of 22kΩ)
1 1kΩ 0.25W 1% resistor (instead of 100Ω)

pin 6 and the ground track from the underside of the PCB. Similarly, LK2 is made using a solder bridge between pin 7 and the ground track. These remarks apply to the revised PCB which is coded 14102112.

If you are changing the original PCB, the IC pads themselves need to be bridged to the adjacent ground track that runs beneath IC1 and connects to pin 5. Note that a solder masked PCB will need to have the solder mask scraped off where the solder is to be applied.

Note also that before these charger options can be used, the microcontroller (IC1) must be programmed with the revised software 1410211B.hex.

New Mosfet

Mosfet Q1 is now a SUP53PO6-20 instead of the original IRF9540. As well, for the 12V version, DSSK 38-0025B double-Schottky diodes can be used in place of the original MBR20100-CT double-Schottky diodes used for D1 and D2.

This new Mosfet has an on resistance of 0.0195Ω (just 19.5 milliohms) compared to 0.1Ω for the IRF940. This will bring about a substantial reduction in the heat dissipated in the Mosfet. Under the same conditions when using a 120W solar panel, the SUP53P06-20 should dissipate about 2W compared to 10W for the IRF9540; a reduction of 8W.

Additionally, the DSSK 38-0025B diodes have an approximate 66% lower forward voltage compared to the original MBR20100-CT diodes. The respective forward voltages are 0.48V and 0.72V at 25°C and at the typical operating current with a 120W solar panel. At 100°C, the diode drops are 0.4V and 0.62V respectively.

Typically, power dissipation for D1 will be 4.82W for the MBR20100-CT and 3.22W for the DSSK 38-0025B diode at a current of 6.7A (the typical current from a 120W solar panel at its maximum power point).

For D2, expected power dissipation at 10A for the MBR20100-CT would be 3.6W at a 50% duty cycle and 2.4W for the DSSK 38-0025B. **So overall power dissipation in the Mosfet and fast recovery diodes when charging at 6.7A will be around 7.6W instead of more than 18.5W in the original circuit.**

The DSSK 38-0025B diodes are rated at 25V and are not suitable for use with a 24V solar panel or battery.

We do not intend giving a full circuit description in this article. Those readers who want the complete circuit description and constructional details should refer to the original article featured in the February 2011 issue. This

Using 24V Batteries & Solar Panels

The Solar Charge Controller can also be used with 24V batteries and 24V solar panels. However, this requires some component changes to the circuit and these are indicated on Fig.3. The changes are as follows:

(1) The 22kΩ resistor at pin 3 of IC2a is changed to 47kΩ, the 100Ω resistor feeding ZD3 is changed to 1kΩ and the 22kΩ resistor at the AN0 input of IC1 is changed to 51kΩ.

(2) The 2200µF 25V low-ESR capacitors are all changed to 470µF 63V low ESR types, while the 4700µF 16V low-ESR capacitors are changed to 1000µF 35V low-ESR types.

(3) The number of turns for L1 is increased from seven to 10.

Note that the dissipation in Q2 will rise to around 500mW but suitable heatsinking is already provided by the case.

Several set-up changes are also required:

(1) The voltage at TP1 (set by VR3) must now be the battery voltage x 0.15625 (instead of 0.3125).

(2) The voltage at TP2 for temperature compensation must be half that set for 12V operation. For example, for 38mV/°C compensation with a 24V battery, TP2 should read 1.9V (not 3.8V).

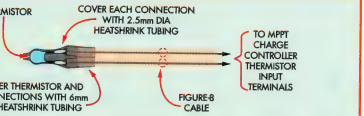


Fig.5: to obtain accurate readings, the thermistor must be mounted in contact with the battery being charged and connected to the MPPT Charge Controller using a length of figure-8 wire.

can be accessed on our website for a fee or you can obtain the back issue from SILICON CHIP.

Thermistor installation

The MPPT Charger case runs quite warm during bulk charging when using the original IRF9540 Mosfet and MBR20100-CT diodes. For this reason, the thermistor should not be simply connected directly to the screw terminals in the box as it will provide a false temperature reading.

For correct temperature monitoring, the thermistor should be mounted in contact with the battery being charged and connected to the MPPT Charge Controller using a length of figure-8 wire. This applies even when the revised Mosfet and diodes are used since the case will still get warm.

The thermistor is soldered to the ends of a figure-8 cable, with the leads insulated using 2.5mm diameter heatshrink tubing. The thermistor and sheathed soldered connections are then further overall covered in 6mm diameter heatshrink tubing, as shown in Fig.5. The opposite end of the wire is passed through a cable gland mounted adjacent to the thermistor screw terminals in the box and secured into the terminals. SC

Keep Cable Resistance Low

When this unit is used with a 120W panel, the charging current to the battery can be as high as 10A. For this reason, the cable resistance between the Charge Controller and the battery should be as low as possible, otherwise voltage losses will affect the changeover from the bulk charge to the absorption stage of charging.

To minimise these voltage losses, mount the charger close to the battery and use heavy-duty cables (see the February 2011 article for details on wire gauges for different lengths).

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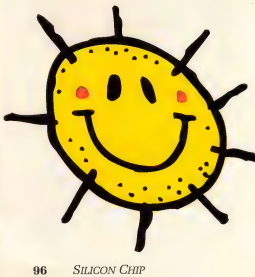
12/24V MPPT Solar Charge Controller

While we know that our revised MPPT Solar Charge Controller will be welcomed by many readers who had requested improvements, there are bound to be other questions, like "Can we now push the revised design to handle more solar panels?" The answers could be yes, no and maybe, as demonstrated by this selection of recent questions from readers. . .



Q I intend to build the MPPT regulator to try this technology out at one of my radio repeater sites. All my sites operate at 12V but it seems there could be a further efficiency gain by using an MPPT regulator with a 24V panel. The original article outlines some component changes to swap the whole system from 12V to 24V so it seems simple to leave the battery side components for a 12V battery but change the solar side components for 24V.

This leaves the inductor which may require a higher value of inductance to operate in 24V to 12V mode. Is this possible or is the inductor likely to saturate if used in this way?

A *It is unlikely that higher efficiency would be obtained using a 24V solar panel with a 12V battery. The high efficiency of MPPT is achieved because the solar panels are operated at their maximum power point for charging and because the panels are at a higher voltage than the battery voltage.*

A 24V panel would be running at about 36V when delivering its maximum power and this would need to be stepped down to between 12 and 14.4V when charging the battery. Compared to the typical step-down from 18V when operating at the maximum power point for a 12V panel, we would expect that the charger will have greater losses when operating with a 24V panel.

The charger would certainly work with a 24V panel and 12V battery although L1 will need to be larger at 20uH with 14 turns on the former. This core should still be suitable for use without any danger of saturation.

Overall, we would not recommend purchasing a 24V solar panel on the off-chance that it will deliver any better overall efficiency than would a 12V panel with the MPPT charger.

On the other hand, if you already happen to have a 24V panel then there is no reason why you cannot press it into service in the way you suggest.

Q I tried improving your solar MPPT project to increase the current output it can handle from a bank of 24V solar panels up to 25A. I removed the existing driver and P-channel Mosfet and substituted a Toshiba TLP350 driver with an isolated drive power supply plus a high-power N-channel Mosfet.

However, I am not getting a proper output from the current amplifier and it is varying around an 18V average with large spikes during to switching. Could you help me fix this issue and suggest a suitable current amplifier stage. I am using a 75mV 50A shunt for the current sensing.

A *The MPPT charger was not designed for 25A. The input and output low ESR capacitors, diodes, the PCB tracks, inductor L1 and fuse etc are simply not rated for this current which is about double that of the original design. You have increased the Mosfet and shunt ratings but left everything else unchanged.*

We are also not aware of how you have arranged the TLP350 Mosfet driver which is an opto-isolated device but its supply would need to be isolated (which you apparently have done) and 18V above the source of the Mosfet, ie, 18V above the battery voltage.

The shunt you are using is 1.5milliohms (75mV/50A) and so with 18V at the output of IC2b and its amplifying by about 45, the shunt must have have 400mV across it and so 266A is flowing. Clearly something is wrong there and it may be due to the shunt being higher in resistance than it should be. If you have used interconnecting leads between the shunt and PCB then the lead resistances may account for a higher shunt resistance; that would cause the higher shunt voltage.

As we have indicated elsewhere in these pages, a higher power MPPT Charger Controller will require a complete re-design, not just a few component changes.

Q&A

Q I built the MPPT Charge Controller and I notice that the Absorption and Float voltages are quite different from what is expected, even when all the voltages are set with calibrated meters. The NTC thermistor has about 2.2V at a temperature is 25 to 30°C. Instead of setting the volts divider ratio near 0.3125 for the PIC ADC input, it seems to work correctly with a ratio of 0.32. Any comments?

A *The battery charge voltages are for a temperature of 20° C. Initially set VR2 for 0V so that the temperature compensation has no effect. A temperature of 30°C will change the battery charging voltage by 190mV due to your 1.9V setting and the 10° C rise above 20°C. So the MPPT charger is probably working correctly with the 0.3125 divider.*

Another possible cause for the discrepancy is the 5V supply which must be at 5.00V, set by VR1, for correct absorption and float voltage calibration.

Note also that the compensation setting for VR2 will affect the absorption and float voltages with temperature above or below 20°C. When VR2 is set for 0V, the temperature has no effect on the absorption and float voltage.

Q I am building a 60ft high antenna tower to provide a better 3G modem signal. The tower will be some distance from the house and no mains power is available. The tower electronics requires 12V at 1.4A and to cover days without sun, a 120Ah battery is required. Your 3-stage MPPT Solar Charge Controller will be used to charge the battery, but I need to use larger solar panels, ie, 12V 180W. Can this be achieved simply by changing D1, D2 and Q1?

A *Use the DSSK 38-00258 diodes and SUP53P06-20 Mosfet of the revised MPPT Charge Controller when using a 180W panel. The inductor core should be OK but the windings should comprise two lengths of 1.25mm wire wound together rather than just using one 1.25mm wire. You should also thicken the PCB tracks for the current carrying sections with a layer of solder.*

The low ESR capacitors should be increased, with the 2 x 2200µF 25V changed to 3 x 2200µF 25V and the 3 x 4700µF 16V to 5 x 4700 16V. The fuse rating needs to be increased to 15A.

The 0.01Ω 3W shunt resistance for current measurement will be suitable but the output from IC2b should be reduced to avoid voltage exceeding 5V at pin 2 of IC1 with full current from the panel. This can be achieved by placing a 4.7kΩ resistor between pins 2 and 5 of IC1, forming a divider with the 2.2kΩ resistor from IC2b's output.

Q I would like to use the MPPT Charge Controller to upgrade my present solar power installation. I have 180W of panels on the roof (3 x 60W) and at times I see up to around 14A at peak sun conditions on cool days. I am adding another single 120W panel and wonder if the unit can be upgraded so that I can run all four panels in parallel through the controller. If not, what sort of issues would you see arising if I used two of these MPPT chargers feeding into the common battery bank, with a single 120W panel on one and the other looking after the three 60W panels?

Even at the higher price it still works out cheaper buying and building up two commercial units that are available with around 10A capacity but not adjustable in terms of voltage settings and do not have the neat features designed into your unit. From my experience with solar setups I cannot see any real problem operating two units in parallel but I have not yet tinkered with an MPPT type so am unsure if there are any traps for the unwary.

A *While the 120W MPPT Charge Controller can be upgraded to 180W (see previous answer) it is not practical to go much above this – certainly not to a total of 300W (as you propose) without a lot of re-designing.*

For example, the low ESR capacitors would need to be increased to suit the higher current and the P channel Mosfet would be need to be paralleled with added gate drive circuitry. Similarly, the two diodes (D1 and D2) would need to be be changed for higher rated types and the PCB tracks thickened along with using a 15A fuse. The inductor would require less turns, from 7 to 6.

However, paralleling two chargers should not cause problems. During charging both Charge Controllers will be delivering power to the battery and will be using MPPT with the solar panels. This is provided that the battery voltage falls below the voltage that each charger needs to begin the bulk charge. This normally happens since the batteries tend to be discharged at night. When full charge is reached the charger with the highest cut off voltage will be the one that continues charging and this will deliver the absorption charge. Similarly during float, the charger with the highest float voltage will dominate the float charging process. This is not important since the absorption and float tend to be at lower current than bulk charging. SC

Vintage Radio

By Kevin Poulter

Atwater Kent Radios – quality with mass market appeal

Back in the June 2011 issue, we told the story of the Wells Gardner radio factory in the United States during the 1920s. This month we have the Atwater Kent story. Atwater Kent was a legendary brand of radios in the 1920s and they were sold in very large numbers in America and also in Australia.

The Atwater Kent Model 20 is an early "big box" receiver, circa 1924.

The Atwater Kent Model E speaker (circa 1928) had a timber-veneer cone.

The 1926 Model 32 used seven valves and was one of Atwater Kent's first models with single-knob tuning.

ARTHUR ATWATER KENT was born in 1873 and his career choice was probably influenced by his father being a machinist, before he became a doctor. Atwater, as he became known, studied mechanical engineering at Worcester Polytechnic Institute in 1895. Not keen on study, Atwater was already running a small business called the Kent Electric Manufacturing Company in the back room of his father's machine shop.

Kent was making and selling electrical items like small motors, generators and fans. By 1906, this included automobile ignitions, with the Uni-Sparker ignition system becoming an industry standard. In 1921, Atwater Kent improved his ignition system further and patented it.

Entertainment radio was saturating the media hype of the early 20s, so in 1921, Kent produced his first radio components, with do-it-yourself kits for "breadboard" assembly by early radio enthusiasts. The Model 3925 (or Model 1) was introduced late in 1922, as a tuner, detector, and one-stage amplifier without the middle variometer installed, in order to avoid Edwin Armstrong's regenerative circuit patent fees.

The variometer was sold separately (frequently being featured in the same advertisement as the radio, although its real function was not mentioned). When this "missing" component was installed by the user, it provided additional RF signal boost through regeneration.

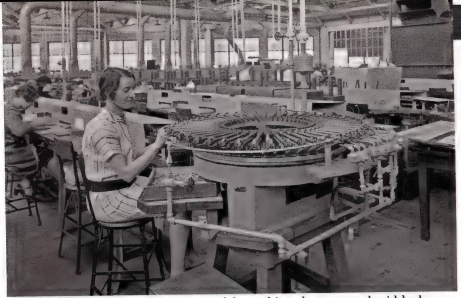
During 1923, his firm produced complete radio sets, with the Model

Released in July 1928, the Model 40 was Atwater Kent's second AC receiver and sold for $US77.

This Atwater Kent 20C chassis in a Pooley cabinet is from 1926 and is battery-powered. The batteries were housed in the cupboards below the radio. Note the station log on the right.

The Model 53 was a mains-powered consolette, circa 1929. This is the model shown in the photo of the press stamping out cabinets and is often referred to as the "stove model", for obvious reasons.

This beautiful piece of furniture discreetly houses Atwater Kent's 1929 Model 55C chassis in a Kiel table cabinet (Kiel was one of the furniture factories used by Atwater Kent). The loudspeaker is downward-facing and the mains cord, antenna and earth lead are hidden by running them down inside the rear legs (mains cord on one side, aerial and earth on the other).

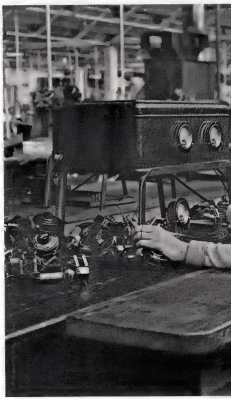


This semi-automatic machine was used for making glass-encased grid-leak resistors.

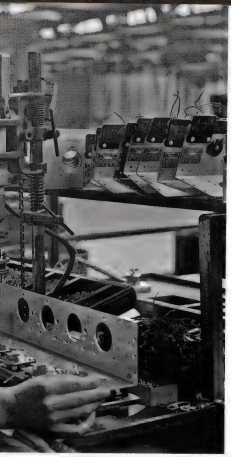
Atwater Kent made their own transformers. Here they are being wound on a former which will later be cut into four coils to be assembled with mild steel laminations.

Atwater Kent made their own variable tuning capacitors. The operator has a row of vanes above her hand and other parts nearby.

Here an industrial grade electric drill is being used to mount hardware on the chassis. The vertical action is via chain-drive from a foot-pedal.

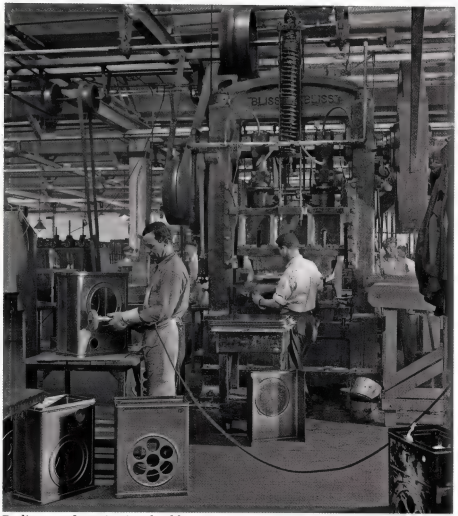


t factory, North Philadelphia, USA



Testing wire-wound potentiometers. Atwater Kent made these too, including most likely the Bakelite knobs.

Here the operator is adding speaker cloth to a circular frame.



Radio manufacturing involved heavy engineering as demonstrated by this large press for stamping Model 53 radio cabinets. The operator in the foreground is buffing a finished cabinet. The hole on the right top was for the volume control and the speaker cloth was covered with a cane grille in some models or woven metal wires painted gold. The 53 had seven holes in the rear to allow for better sound, with a chassis the same as Atwater Kent's Model 43.

Making a variable capacitor and coil assembly. All the individual parts would have been manufactured in the same factory.

Atwater Kent in the test department. The radios appear to be Model 20C's, the most popular model Atwater Kent made, with about 250,000 units produced from 1925-1927. Note the battery banks on the floor.

This department was devoted to coil assembly. Some of these coils appear to be intended for use in power and audio transformers.

10 ready for Christmas that year. This was followed by the Model 9 and more breadboard sets. According to an employee, Mr Kent had already decided to close his plant in 1923 and was winding down his operations. However the increasing sales of radios apparently changed his mind and he expanded instead.

In 1924, the company moved to a new $2 million plant in North Philadelphia. This plant, constructed in sections, would eventually cover 32 acres (13 hectares). The Atwater Kent brand became known as a leader in quality radios and despite high prices, people recognised they were one of the very best money could buy. He spent a staggering half million dollars on advertising alone during 1924.

By 1925, Atwater Kent was the largest manufacturer of radios in the USA. The company also sponsored the popular "Atwater Kent Hour", a top-rated radio concert music program broadcast across the country from 1926-1934. Sponsoring this show cost $7000 a week in 1926-7 and his printed advertising outlay was three to four million dollars!

Single dial tuning

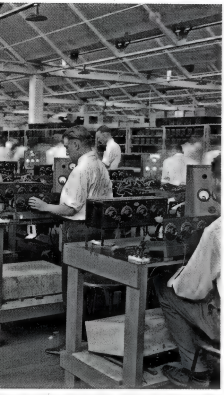
Atwater Kent saw that single dial tuning would be a very popular upgrade to the Model 20. Linking the second and third tuning dials by belt-drive worked but not so linking in the first stage. Then John Miller (who also discovered the "Miller effect") added a valve between the antenna and the first tuned circuit, thereby isolating this circuit and making it tune in unison with the others. And so, with a few other modifications, the 20 chassis became the Model 30 with single-knob tuning.

Business was booming but not without forks in the road. In 1925, 17,584 Model 21s were produced but 7208 were returned in 1926. Still, within four years, Atwater Kent had sold one million radios to American homes and began exporting to countries like Australia.

The Australian connection

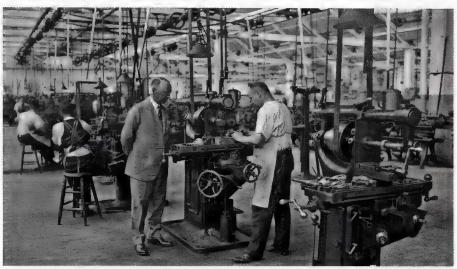
In 1927, Healing Australia was

siliconchip.com.au



This is the capacitor winding department. These capacitors use paper as the dielectric and tin foil for the electrodes. They are wound on a circular mandrel, then flattened, terminated with wires and installed in tin cans whereupon they would have been impregnated with wax or petroleum jelly in a heated vacuum chamber.

Atwater Kent's 1934 advertisement for the powerful models few could afford. Note the two single plate 2A3 push-pull audio valves in the top left of the chassis, highly coveted by the audio fraternity.



Atwater Kent in the machine room. This department would have been involved in making all the tools and dies used in the radio factory. The two units in the foreground are milling machines while the one behind Atwater Kent is a shaper. Notice that all the machines are belt-driven from overhead horizontal shafts.

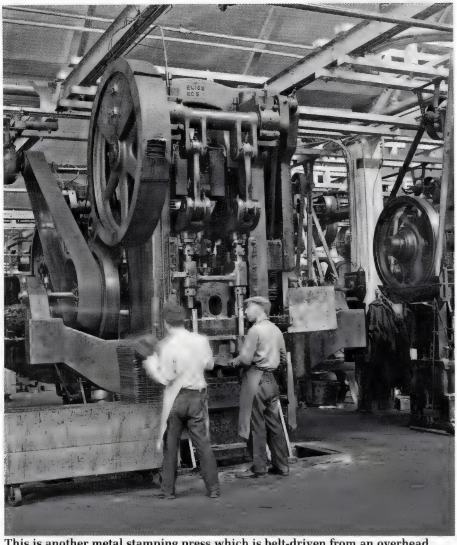
importing Atwater Kent radios and there is little doubt this established Healing in the Australian market. They sold them by the thousands, especially the models 20C and 35, plus the model L horn speaker, right up until tariff barriers were put in place by the Scullin government in late 1929. Even then, Healing used Atwater Kent components extensively in their early Healing-branded sets.

Mains-powered sets

On December 24, 1927, Atwater Kent's first purpose-built AC set, the Model 37, went on sale for $88. Its performance approached that of its main competitor, RCA's Model 17. However, at nearly half the size and against the RCA set's $130 price, it made a big impact on the market.

At its peak in 1929, the company employed over 12,000 workers producing nearly one million radio sets a year. As seen in the accompanying photographs, the plant was a model of quality radio production and received hundreds of visitors a year.

Two days after the financial crash in 1929, Atwater Kent issued a statement: "The Atwater Kent Manufacturing Co. has never had any shares of its stock on the market. It owns outright its business and its manufacturing plant. It has been in business for more than



This is another metal stamping press which is belt-driven from an overhead electric motor. The large flywheel is used to store energy and this is released in each stamping operation. These days such presses would be hydraulic.

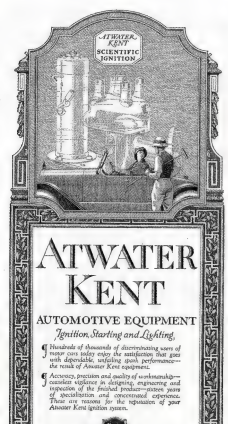
This operator is soldering flying leads to coils, using a much bigger iron than we would use today.

An Australian advertisement in July 1927, placed by A.G. Healing, distributors of Atwater Kent radios.

In June 1928, E.T. Muir of Melbourne announced they were the sole metropolitan outlet for Atwater Kent radios and speakers. The phrase "chosen by more than a Million" actually referred to sales in the US.

twenty-seven increasingly profitable years, has always done business on its own capital and has never borrowed a dollar. All its resources and experience are concentrated upon just one thing – the making and selling of fine radio instruments.

Production in its thirty-two acre factory is scientifically controlled, so that Atwater Kent dealers always have enough radios on hand to meet the public demand and are never



Atwater Kent manufactured ignition systems for many years before moving into radio production.

Did people really dress formally to listen to the radio? We think not but such an elaborate "wireless" as depicted here could only be afforded by the very rich.

overstocked. Its inventory is never excessive. Single-minded devotion to its one job – the production of the finest radios that can be built – has put the Atwater Kent Manufacturing Company today in the strongest position it has ever held."

Atwater Kent made good market predictions over the years and met the upcoming trends. However, he then thought that consumers wanted more consoles and invested accordingly. This was proven wrong, as people now looked for economy sets. During 1930, superheterodynes were included in their range of about 15 radio models each year. These included consoles, table models, car radios, direct current (DC) sets, battery sets, and radios using 32V power for farm and rural areas where mains power was not available.

By 1931, the company boasted it had produced over three million radios. However, the depression was not a good climate to sell quality radios, so Atwater Kent closed his engineering department.

To meet the lower price expectations, the plant built table-top radio sets but Atwater Kent still made little compromise on quality. In addition, patents for Edwin Armstrong's superheterodyne circuit expired, so there was soon a deluge of inexpensive "All American Five" radio sets.

As a consequence, Atwater Kent shut down his radio factory in 1936. The plant was purchased by a major local competitor, Philco, who had branched out into air-conditioners and refrigerators.

Prized by collectors

As Atwater Kent radios were high quality, many have been restored by Australian and American collectors today. Cabinets were made by the Red Lion, Kiel and Pooley furniture companies, with the best consoles being the finest furniture. One radio was sold inside a grandfather clock.

Atwater Kent enjoyed the lifestyle of a wealthy man, with a vacation home on Mt Desert Island, Maine. The house was known for its marble staircase, vaulted ceilings, a foyer that opened onto the ocean and superb gardens. "Sonogee" was owned by the Vanderbilts before Mr Kent acquired it. He also had a house at Kennebunkport, Maine, which he named "At Water's Edge", also once owned by the Vanderbilts. Mr Kent's Philadelphia home was his "West Hills" estate.

He "retired" briefly to Florida, running a real estate business, then in 1941 moved to Bel Air, California, where he purchased a 32-room mansion named Capo di Monte. Located atop the highest hill in Los Angeles, this estate was well-known as a venue for lavish parties, attended by numerous Hollywood personalities. He lived there until his death in 1949, leaving more than $9 million to family, friends, servants and institutions.

Credits

(1) The Library of Congress (USA);
(2) All photographs restored by Kevin Poulter;
(3) Thanks to HRSA members Mike Osborne and Richard Begbie.

Recommended reading

Alan Douglas' Radio Manufacturers of the 1920s, Volume 1. Considerable technical information, including circuits, can be found on the web. SC

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Flea-power Ultra-LD module

Kits for the Ultra-LD Mk.3 module represent great value; better value than the SC480 (SILICON CHIP, January & February 2003) with upgraded output transistors. Which prompts the following question: how low a supply voltage will the Ultra-LD Mk.3 work on (with reduced output power, of course) – ±20V?

Do any other changes need to be made to allow it to work on reduced supply voltages? (I. F., via email).

● The Ultra-LD amplifier should work OK with supply rails down to ±20V but you would be severely limiting the power output. Having said that, you could also dispense with one pair of output transistors and the associated 0.1Ω resistors. The fuse ratings should be reduced as well, down to 1A or 2A.

Drill speed control for home-brew grain mill

I want to use an electric drill to drive a small roller type grain mill. I am a home-brewer. The design speed is ideally 200 RPM but up to 300 RPM is OK. My existing older model Bosch drill has a 1000 RPM low-speed range but does not have any variable speed control. A decent 2-speed drill will set me back $200 or more.

I suspect that I might be better off making a 10A Universal Motor Speed Controller, Mk. 2 for $100 from Jaycar (as described in your February 2009 issue) and use it with my existing drill. I also presume that your controller would be an improvement on the variable speed control supplied with most of the drills sold over the counter. Would you please comment on my suggestion before I make a commitment. (P. B., via email).

● 200 RPM is really too low to be practical with a drill that is intended for use at 1000 RPM. A better approach would probably be to adapt a battery drill/screwdriver which can be used at low speeds and deliver high torque. These are quite cheap to buy; much cheaper in fact than the kit for the 10A speed control at $100.

100V line adaptor needs more output

Some time ago, I set up 100V line speaker cabling throughout our church buildings to enable audio from the sanctuary or other locations to be heard elsewhere if it was needed. The system works well with a 100V line output amplifier driving up to six 30W Redback column speakers with more than adequate volume. I have also set up VGA over Cat.5 video to the same areas.

I built the 100V-to-Line Level Adaptor described by Ross Tester in the May 2006 issue of SILICON CHIP, to put the 100V signal into another amplifier where there was already a PA mixer/amplifier system set up. The problem I encountered is that despite having very high volume levels on the 100V line system, the line level output from the adaptor requires near maximum amplification to be sufficiently loud.

Recently, I connected the adaptor to the audio line input of a large-screen monitor to trial using only a monitor with its own audio rather than monitors with audio from separate speakers. I cannot get enough volume to hear the audio adequately. Audio from other sources is fine, with more than adequate volume.

Is there any way I can modify the SILICON CHIP 100V to line level unit to get more volume or will I need to provide some additional amplification

Turn Down The Thermostat For Power Savings

I found another "power saving device" in my inbox recently, this time advertised via what I consider a reputable discount email so I was intrigued to see whether it would work! However not only did I find misleading advertising but also the normal incorrect claims: **http://thepowerpanda.com/the-power-panda-2/**

Agreed for industrial systems hot water may be on 24/7 but for residential they are ripple controlled, are they not? Therefore, if installed correctly (after the relay) would you not be able to program on-times during the day?

Also if the installer decides to either use a mains feed or skip the ripple relay, then the mandatory control of hot water systems is also side-stepped, rendering a potential problem during times of generator-enforced power savings.

While I think the concept could be good, I am concerned its advertising claims will leave the consumer assuming they are solving problems they don't have! What is your opinion? (J. C., Auckland NZ).

● It sounds like complete nonsense. Most electric hot water systems in homes are off-peak and thermostatically controlled so the potential for large power savings is very small. The best method is to turn down the thermostat to the safe level of 60°C.

Hot water systems used in home units, offices and factories are connected permanently but they are still thermostatically controlled. Arguably you could fit a timer so that the tank was not connected to the mains supply out of normal operating hours in an office or factory but the savings are still likely to be minimal. Perhaps the best way of getting savings would be to better insulate the tank and again, turn down the thermostat.

As for a hot water tank's consumption being affected by fluctuations in the mains, that's ridiculous; it is just a resistive load.

Is Multi-Channel Recording Possible With The USB Interface?

I think the USB Recording Interface in the June 2011 issue is an excellent project. I was wondering, would it be possible to sync two or more units together, for multi-channel recording?

My personal interest is in transcribing 1970s "Quad" vinyl LPs but I'm sure that many small recording studio owners would also benefit from this. Would it be as simple as replacing the crystal oscillator with a buffered logic gate design and feeding the resulting 12MHz to XT1 on two or more PCM2902 chips?

Would two or more units synced in this way be recognised as a multi-channel input by popular DAWs such as Audacity? I know that Audacity supports multi-channel recording but I'm not sure if the Windows drivers would support more than just stereo. (B. C., via email).

● As far as we are aware, the TI PCM2902 USB codec chip used in the June 2011 USB Recording/Replay Interface doesn't lend itself to multi-channel recording, at least in a way that would be compatible with standard recording software like Audacity.

Even though it would be possible to run a number of PCM2902s from a single 12MHz crystal oscillator as you suggest, this would only synchronise them in a basic sense. You would still have to merge the resulting bit streams to feed them as a multi-channel bit stream to the PC.

Perhaps the easiest way to achieve true multi-channel recording would be to use a number of ADCs (not PCM2902s) locked together, then use a multiplexer to combine their outputs into a single interleaved bit stream. This could then be sent to the PC, either directly via a USB interface or after conversion into an S/PDIF bit stream.

of the signal before connection to the monitor?

● Just reduce the 100kΩ resistor. Try a value of 33kΩ, for example.

Smoke alarm with photo-optic sensors

I have a Smoke Alarm Control Panel (SILICON CHIP, January 1997) that I am updating with optical smoke alarms that have the MC145012 photoelectric smoke detector IC.

The only thing that is not working is the alarm test from the panel test button. I have connected the alarm test wire to pin 16 of the IC via the low side of the test button on the smoke alarm but the 5V is not triggering the alarm, as it needs 9V to operate.

Have you any suggestions to rectify this? (A. B., Port Macquarie, NSW).

● The 10kΩ resistor in series with the alarm test switches from the 9V supply is too large in value and drops too much voltage when a switch is pressed. That is because the 10kΩ resistor drives transistor Q5's base via another 10kΩ resistor, so the voltage available for the MC145012 test pin is only about 4.85V.

Try a 1kΩ resistor in series with the alarm test switches (S1-S10). This resistor is located just below diode D21 on the PCB.

Vox for marine use

The Vox project in the July 2011 issue is almost perfect for my project but I need to make a couple of modifications.

The article said that the signal sensitivity can be adjusted to cover a wide range from microphone levels up to line levels of 2V RMS, For my application, I want to feed the circuit in parallel with the external loudspeaker of a marine radio, to mute the stereo if there is activity on Channel 16. Therefore, the input signal will be higher than the intended 2V RMS.

In addition to this, it would be useful if the frequency response of the VOX could be tailored to a narrower bandwidth of say, 100Hz to 4kHz (at minimum gain) to reduce spurious activation.

I guess that a resistor network on the input could be used to reduce the signal to 2V but I've looked at the data sheet for the LM358M and I can't find any references to reducing the bandwidth. Can you suggest how to achieve these? (N. M., Cranbrook, UK).

● For a higher input signal level, it would be best to attenuate the signal so that the sensitivity is still adjustable using VR1. A 2.2kΩ resistor to ground from the junction of the 10kΩ resistors at the input and the 100nF coupling capacitor to pin 3 of IC1a would attenuate the signal by 5.5. This would allow up to an 11V signal level for triggering.

The low-frequency roll-off can be increased to 100Hz by reducing the 100nF capacitor value at pin 3 of IC1a to 15nF. The high-frequency roll off is variable with the gain of IC1a and VR1's setting. A 3.9nF capacitor added across the 2.2kΩ attenuating resistor (mentioned above) would roll off signal at 4kHz before reaching IC1a.

Preamplifier for ribbon microphone

I have a very old (but excellent) Lustraphone VR/53 ribbon microphone. Lustraphone also made these for the BBC and Grundig. My best preamp is the "Front End for PC Audio Recording" by Jim Rowe in the September 1998 issue of *Electronics Australia*. It works very well for a Shure SM58 but is a "dog" with the ribbon.

As you know, good ribbons are lucky to put out 1mV and the Lustraphone is no exception. Even running it through a 50Ω to 5kΩ external mic transformer results in a lot of noise.

One of the problems is clearly that the front-end preamp is not balanced (much of the noise is hum). The microphone has a very low impedance, 20Ω I think and that's after the internal mic transformer.

I looked at your Balanced Microphone Preamplifier from August 2004. Its sensitivity is too low for this mic so I need to lift the gain, which will probably compromise noise. Studios often put a 20dB direct-coupled preamp between mics (especially ribbons) and the pre-mixer. Have you done a balanced direct-coupled 20dB very low noise preamp? Or anything like it?

Impedance matching with low impedance ribbons is usually not an issue provided the input impedance in the preamp is at least 15 times the

Running Smoke Detectors From 3V DC-DC Converters

I purchased four 3V-To-9V DC-DC Converter kits (Silicon Chip, March 2004), each with two AA batteries, to replace the 9V batteries in four smoke detectors in my home. However, the alarm keeps going off at times for no apparent reason. When I put in normal 9V batteries, they seem to work OK.

Do you know if there is anything that can be done so they will work properly and be suitable for smoke detectors? (J. P., Palmyra, WA).

● Using that particular DC-DC converter in smoke detectors is probably not a practical proposition. Typically, smoke detectors draw only about 9μA from a 9V battery. This current is very low and so the batteries should last a long time. By comparison, the DC-DC converter itself draws 80μA from the AA cells, plus about 30μA to supply the 9μA for the smoke detector. So two AA (alkaline) cells should provide at least a 2-year lifespan; not much different to a 9V alkaline in a smoke detector.

Note that smoke detectors actually draw relatively high current (10mA) pulses from the battery during battery test. The standby current also rises during smoke tests to 50μA. These current pulses may be causing changes in the 9V supply that could set the alarm off. Using larger value and low-leakage bypass capacitors in the DC-DC converter may help.

Another possibility of false smoke alarm triggering is that switching noise from the DC-DC converter is entering the smoke detector via the high-impedance ionisation sensor input. To solve this, you could try positioning the DC-DC converter away from the smoke detector so that noise is not picked up by the sensor input. Alternatively, you may be able to incorporate some shielding.

All that said and done, if the DC-DC converters are causing problems, we would revert to normal 9V operation. Where the DC-DC converters are more practical is in applications which have a high current drain and consequent short operating life for 9V batteries.

impedance of the microphone (passive ribbon). Any suggestions? (J. K., via email).

● A balanced preamplifier is definitely required for any microphone with low (<50mV) output or else hum will be significant. The August 2004 Balanced Input Microphone Preamplifier could be used and its signal-to-noise ratio could be improved using LM833 op amps instead of the TL072s, especially for the first stage based on IC1.

Its gain can be increased by increasing the two 3.3kΩ resistors at pins 5 and 6 of IC1. You probably only need to increase these to 15kΩ each and reduce the capacitors to 220pF.

Alternatively, the Balanced-To-Unbalanced Converter from June 2008 could be used. The gain is set by resistor R1. This can be used as the balanced 20dB stage for a following unbalanced input preamplifier.

Ferret detector on 457kHz

Can the Portable Lightning Detector (Silicon Chip, July 2011) be used to detect a 457kHz transmitter? This transmitter is used as part of a system to find ferrets underground (the receiver is not working).

The distances are usually well under three metres. The transmitter emits a pulse; its very small and you attach it via a collar to the ferret. The receiver usually tells you where the ferret is and approximately how far down. I can modify the Lightning Detector if you think it will work. (M. H., via email).

● The Lightning Detector can receive 457kHz but would need to be tuned to that frequency with a capacitor across the tuning coil. You will need to adjust the capacitance to get the best reception. Around 200pF would be required. However, the Lightning Detector itself will not indicate the depth and direction so it may not be suited to your application, unless it is further modified.

Dual purpose PCB for Hot Wire Cutter

I am building the Hot Wire Cutter (Silicon Chip, December 2010) but the layout on the PCB that I ordered from you doesn't seem to match that of the article. There seems to be an extra diode (D2) on the PCB.

I checked the Notes & Errata on the website but didn't see any reference to it. (B. H., via email).

● Hmm – perhaps we were a bit too clever here. We designed the Hot Wire Cutter with another purpose in mind and included the extra diode for this reason. With D2 installed, the unit can be used as a DC motor speed controller. D2 clamps the motor's back-EMF, protecting Mosfet Q3. Hot wires are not inductive like motor windings, so D2 is unnecessary for the hot wire cutter role.

The information on how to use the PCB as a motor speed controller is in the "12V Speed Controller/12V Lamp Dimmer" project from November 2008. The December 2010 Hot Wire Cutter is essentially an update of that design. So for your application, omit diode D2.

High-power signalling light

Is it possible to modify the LED Dazzler (February 2011) for use as a Morse signalling light? Would it be possible to connect a Morse key or computer-driven relay somewhere in the dimming circuit to dim the LED to zero and then to full brightness on key down?

With suitable optics, a cheap 3-inch lens and a plastic tube, it should be possible to make a quite powerful and robust signalling lamp by using a 10W LED.

We are also looking at fitting the LED Dazzler with two strings of LEDs, one white for cabin lights and the other red for night vision. Our only problem is finding a simple foolproof way of preventing switching of the strings from open circuiting the output while the unit is operating. (R. J., Glendale, Qld).

● You could key the LED Dazzler on and off by grounding pin 7 of the 555, IC3.

Confusion on versions of LMC6482 op amps

I have a query regarding the numbering convention on the LMC6482 dual

CMOS op amps used in the Digital Audio Signal generator (Silicon Chip, March-May 2010). The lettering for each is IN / NOPB & AIN / NOPB.

The only difference that I can ascertain is the common mode rejection ratio (65dDb versus 70dB) and the input offset voltage (3mV @ 5V versus 0.75mV @ 5V).

Would you be able to confirm which IC is suitable for the project? I have looked at the National Semiconductor site on naming conventions but not much clarifies the lettering (S. F., Carina Heights, Qld).

- The LMC6482AI is just a "binned" version of the LMC6482, with better guaranteed performance in areas such as input offset voltage. The "I" version is not as good as "AI" but better than "M".

None of the parameters which vary between the various types are critical with the Digital Audio Signal Generator, so you can use whichever version you prefer. The LMC6482 was chosen mainly because it has rail-to-rail inputs and outputs and will run off the low supply voltage available.

Tuning problems with a Theremin

My father bought me a Theremin kit (Silicon Chip, August 2000). I recently finished it but there are problems.

There is a tone coming out of the speaker, the pitch of which can be altered by moving my hand toward and away from the antenna. However, I can't seem to get adjustable volume, either from the volume pot on the case, nor from the volume plate.

In fact, as I move my hand toward and away from the volume plate, it is the pitch that is affected!

I read an "Ask Silicon Chip" answer from a guy who seemed to have run into similar but not identical problems and the reply was that perhaps the power supply was the wrong type. My power supply is an unregulated 6V supply which actually put out around 10.5V and it's rated at 300mA. There was a mention in the reply that the power supply should not be "earthed to the negative terminal." Not sure how I test this but the earth pin of the mains plug is certainly metal not plastic.

Of course, I set it up and checked it in accordance with the instructions, and had some bizarre results. Pin 8 of IC2 and pin 6 of IC3 are fine. I have to adjust VR2 fully clockwise to get 4.33V on pin 1 of IC2. Then, however I adjust T4, the voltage at the cathode of D1 is always about 0.6V. And then the handling doesn't seem to change when I adjust VR2. (T. H., Sheffield, UK).

- It can happen that the frequency of

. . . continued on page 112

Will The SemTest Measure Germanium Transistors?

I didn't find specific reference in the first article on the SemTest's ability to test germanium transistors.

I repair many early solid-state car radios for various clubs and I currently use a Peak transistor tester, which has its limitations. Its main advantage is that it automatically identifies the pin-out regardless of how it is connected; no data books required. The only downside is that it will sometimes identify germanium transistors as diode arrays.

The SemTest will do a lot more but it requires knowledge of the lead configuration. Maybe in another 40 years version two will be released with auto configuration? (K. C., via email).

- The SemTest should be able to test germanium transistors quite happily as it stands but it's not intended to fully characterise power devices of either the silicon or germanium variety.

We did give some thought to building in "auto configuration" or auto lead identification but decided it would be a bit too complicated for this "first microcontrolled" tester, especially with regard to Mosfets and thyristors.

Notes & Errata

UV Light Box & Timer (November 2007): transistors Q5 and Q6 are shown incorrectly on the overlay diagram of Fig.3. Q5, a BC547, should be placed in the Q6 position and Q6, a BC557, placed in the Q5 position. RA4, pin 3 of IC1 for the select switch (S1) should also be pulled high to the 5V supply via a 10kΩ resistor.

While the start switch (S2) and set switch (S3) connections at the RB6 and RB7 pins of IC1 are pulled high via internal high value pull-up resistors, these two inputs should have 10kΩ pull-up resistors to prevent false triggering due to transients, especially when the UV lamps are starting. 100nF capacitors across S1, S2 and S3 can also reduce false triggering.

WARNING!

Silicon Chip magazine regularly describes projects which employ a mains power supply or produce high voltage. All such projects should be considered dangerous or even lethal if not used safely.

Readers are warned that high voltage wiring should be carried out according to the instructions in the articles. When working on these projects use extreme care to ensure that you do not accidentally come into contact with mains AC voltages or high voltage DC. If you are not confident about working with projects employing mains voltages or other high voltages, you are advised not to attempt work on them. Silicon Chip Publications Pty Ltd disclaims any liability for damages should anyone be killed or injured while working on a project or circuit described in any issue of Silicon Chip magazine.

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Ask SILICON CHIP

. . . continued from p109

the reference oscillator and the volume oscillator are so close that they lock and so hand movement does not cause the volume oscillator to change. To counteract this, adjust the reference volume oscillator transformer (T3) about one turn either clockwise or anticlockwise from its current position and then readjust T4 again according to the volume plate alignment procedure described in the article.

Alternatively, T3 and T4 are currently adjusted so that T4 cannot come within frequency range of the T3 oscillator. Try setting both the T3 and T4 slugs to mid-travel of their adjustment range first. Then readjust T4 again according to the volume plate alignment procedure described in the article. There must be a voltage change available at D1 with hand movement before volume will be controlled.

The August 2000 Theremin will work well with an earthed or unearthed supply. It does not work with the newer switchmode plugpacks. The later Mk.2 version from March 2009 was designed to operate from an AC plugpack only. It will not operate from a DC supply or a switchmode plugpack. The Ask SILICON CHIP answer you are referring to was probably for the Mk.2 version. **SC**

Multi-Channel USB Recording/Playback Interface?

I was very happy to see the USB stereo recording/playback interface project (SILICON CHIP, June 2010) and was wondering how I can have multiple channels for music creation/production at home.

For example, I want to have eight or more inputs for use with Cubase software. So, can I run four of your boxes on a desktop PC? Is there any chance of you doing a multi-channel version for home studios?

Commercial units are too expensive for a home hobbyist. (D. C., via email).

● Unfortunately it's not feasible to hook up four of our Stereo USB recording/Playback Interfaces to a PC for 8-channel recording.

In order to do this, you'd need an ADC-bitstream chip which could handle all eight channels at once and interleave them "in sync" for sending to the PC. That's probably the reason why the commercial units are so expensive.

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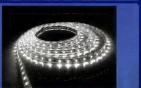

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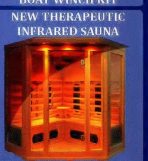

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